ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLIX. No. 23. NEW YORK, SATURDAY, DECEMBER 8, 1906. ISSUED WEEKLY

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NEW YORK

PUBLISHING OFFICE . . . . . 13-21 PARK ROW

CHICAGO

WESTERN OFFICE, L. W. MARSHALL, Manager, . . MANHATTAN BUILDING

BOSTON

NEW ENGLAND OFFICE, ... 95 MILK STREET

LONDON

EUROPEAN OFFICE, HENRY W. HALL, Manager, 42 OLD BROAD STREET, E. C.

TELEPHONE AND CABLE

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single copy, 10 cents. Back numbers, beyond one month, each . . .25

ADVERTISING

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

Entered at the Post Office at New York as second-class matter under the Act of March 3, 1879.

CONTENTS

EDITORIAL:
A Development in Radiotelegraphy 917
Alternating Currents for Incandescent Lighting 918
Electricity 919
The Use of Storage Batteries in the Electric Lighting of Steam Passenger Equipment, by J. R. Sloan 920
For the Preservation of Niagara Falls 923
Transformation of Electric Power into Light, by Charles Proteus Steinmetz 924
American Institute of Architects 926
Polyphase Systems of Generation, Transmission and Distribution, by M. A. Sammett 927
Production of Electrical Machinery in 1905 929
Erie Electrification 930
The Electrical Trades Society of New York 930
Convention of the Northwestern Telephone Exchange Company 930
Units and Standards 931
Cassier's Magazine 932
Death of Arthur Vaughan Abbott 932
Railway Generators Operated on a Three-Wire Lighting Service 932
Two Exhibitions in Holland 932
The Entraygues (France) Hydroelectric Plant, by C. L. Durand 933
Capacity of a Battery of Accumulators Operating at Variable Output 937
New Types of Incandescent Lamps, by Clayton H. Sharp 938
"Seeing Electrically" 943
What Is an Engineer-Constructor? by George A. Damon 944
Electrical Notes from Great Britain 946
The Faraday Society 948
Report on the New York Telephone Situation 949
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 950
METHODS OF GETTING NEW BUSINESS—"Advertising Electricity," by Frank B. Rae, Jr 952
American Institute of Electrical Engineers' Land and Building Fund 954
Technical Publicity Association 954
Large Power Scheme for Paris 954
Illuminating Engineering Society 954
INDUSTRIAL SECTION:
Electric Motor Drive in the Packing Industry 955
Allis-Chalmers Electric Hoists 956
BOOK REVIEWS 957
CURRENT ELECTRICAL NEWS 958
DIRECTORY OF ELECTRICAL AND ALLIED ENGINEERING AND SCIENTIFIC SOCIETIES 962
RECORD OF ELECTRICAL PATENTS 963

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A DEVELOPMENT IN RADIOTELEGRAPHY.

A result for which many have sought in radiotelegraphy is that of producing undamped electrical oscillations of fixed frequency. A successful method of doing this would reduce the problem of tuning to a simple matter and would at the same time greatly increase the power of a given system, since it would make possible the utilization of a train of waves to actuate the receiving device, whereas with the ordinary methods where damping occurs dependence must be placed upon the energy of the first wave. Many have attempted the solution of this important problem, with more or less success. The latest contribution to this work has been made by Valdemar Poulsen, who is well known as the inventor of the Telegraphone, that device which registers a telephone conversation on a steel disc or wire.

The line of attack adopted by Poulsen was begun by Duddell, who made an exhaustive study of the so-called singing arc. When the electric arc is shunted by a circuit containing capacity and inductance electrical oscillations may be set up around the circuit, the frequency depending upon the constants of the circuit and the conditions at the arc. Such a circuit becomes, then, a source of continued oscillations, which might be of value in wireless telegraphy, if the frequency of the oscillations can be carried high enough and if this frequency can be made sufficiently constant. Duddell succeeded in reaching from thirty to forty thousand oscillations per second, which was not sufficiently rapid. Poulsen, starting from this point, has, by making a careful study of the arc, carried the frequency to about 700,000 per second. He accomplishes this by surrounding the arc with hydrogen gas containing a small amount of hydrocarbon vapor. This frequency is sufficiently high for use in wireless telegraphy, so that the problem is thus partially solved. It remained to operate the arc under conditions which would give a constant frequency, which was finally done by holding the arc in a fixed position by means of a magnetic field, which, as is known, repels the arc; and by constructing the electrodes so as to maintain the length of the arc rigidly constant. To prevent changes in length due to the action of the arc on the electrodes the positive electrode is made of copper and kept cooled by circulating water through it; while the negative is made of carbon of larger size with a sharp edge, and is kept revolving at a slow speed so as to present constantly a new point of contact to the arc.

With this device it is possible, according to Poulsen, to obtain oscillations of any frequency desired, and at the same time to hold the frequency constant, so that tuning within one

per cent is easily obtained. The few practical tests which have been made public agree with this assertion, since communication was maintained over considerable distances with the expenditure of a small amount of power at the transmitting station. It would seem that the new method of generating electrical waves should be of the greatest importance in this comparatively new art.

There are several advantages with such a system. First, the use of undamped waves of fixed frequency makes accurate tuning possible and makes it possible also to operate a large number of stations within a given district without interference. This is a very important gain. The other gain, that of increasing the possible distance of transmission or decreasing the energy required for a given distance—which is the same thing—is likewise important, but to utilize this effect requires that advantage be taken of the prolonged train of waves sent out; in other words, the receiving devices must be such as to allow a comparatively long series of waves to set a comparatively large amount of energy into motion, which then actuates the recording apparatus. To accomplish this it is necessary that the receiving circuits be arranged so as to be set in oscillation without much damping, and since most of the recording devices now employed have a large damping effect when connected to the receiving circuit, it is desirable that these should not be connected permanently, and only after the receiving circuit has been set into oscillation. A method of accomplishing this has also been devised by Poulsen, which thus enables him to reap the benefits of his wave generator. The arrangement is simple enough, as it consists merely in making an intermittent connection between the signalling device, such as a telephone receiver, and the oscillating circuit. This can be done by a revolving star wheel or in a number of ways. The effect is to leave the oscillating circuit free to oscillate undamped, except during the periodic closing of the telephone circuit, at which time energy which has been set into oscillation by a comparatively long train of waves is turned into the telephone receiver to produce a click. These clicks succeed one another at a frequency which, of course, depends upon the number of contacts, and produce a note of corresponding pitch.

Poulsen thus seems to have contributed two important devices to the art of radiotelegraphy. He has developed a generator of undamped electrical waves and has devised a means of utilizing the energy of a train of waves. The results of a more extended experiment with this system will be awaited with considerable interest.

ALTERNATING CURRENTS FOR INCANDESCENT LIGHTING.

An interesting and suggestive section of the paper read by Dr. Clayton H. Sharp at the recent meeting of the American Institute of Electrical Engineers is that dealing with the flickering of incandescent lamps on alternating currents. Incandescent lamps, as is well known, can not be used indiscriminately on alternating-current circuits, since on low frequencies such as twenty-five cycles per second, the frequency most generally employed in this country for transmitting power, there is a perceptible and disagreeable flickering. The flickering depends upon the candle-power of the lamps and upon their so-called efficiency—that is to say, the watts per candle-power. The larger and thicker the filament, the less will it vary in temperature due to the pulsating character of the heat development. On the other hand, the higher the efficiency be—in other words, the higher the temperature—the greater will be the fluctuation of the light. But, combined with these effects, is the physiological effect. The behavior of the eye should always be borne in mind in any study of problems in illumination, and in this one it is the action upon the eye which really decides the question. The efficiency of the lamps as producers of light is apparently just as good at low frequencies as at high, so that it is resolved down to a question of the effect upon the eye. Thus, although the variation in luminosity of an incandescent lamp will be greater if the watt consumption per candle-power be low, if the intensity of illumination or the intrinsic brilliancy be carried high enough, the dazzling effect upon the eye may mask the flickering.

Low frequencies for incandescent lighting are employed in some instances. A notable one of these was the lighting at the St. Louis World's Fair, which was done at twenty-five cycles. Probably very few of those visiting the fair realized this—in fact, many could not detect a flicker even when their attention was called to it. This flickering, it may be mentioned, is in general not observable when the eye looks directly at the lamp, and is only seen when the line of vision is directed a little to one side, so that the image of the lamp does not fall upon the centre of the retina. In the latter case the eye is too dazzled to observe the variation. It is still a question, however, whether the variation which does take place but which is not observed under proper conditions tires the eye more than a uniform light or one at such a frequency that the variations can not be observed. It may be mentioned that two effects occur if the frequency be increased. Thus not only is less time allowed for a change in the temperature, but there is a similar effect upon the eye which renders it incapable of following the more rapid variations.

The development of the metallic-filament lamps naturally suggested that since the characteristics of the metals give the lamp a certain amount of inherent regulation, that it might be possible to use such filaments on alternating currents of frequencies lower than those found suitable for carbon-filament lamps. In other words, since the resistance of the filament increases with the temperature, the current, and hence the temperature of the filaments will vary less during the cycle than will those of a corresponding carbon filament. This is true, but unfortunately another characteristic of the metallic filament offsets these advantages. Since the metal has a lower resistance than carbon, the filaments are made much thinner and longer, and therefore, having a greater radiating surface for a given weight, will follow the energy changes more rapidly.

To determine just what will be the result, Dr. Sharp conducted a number of experiments with the idea of not only determining the performance of the metallic filaments at various frequencies, but of comparing such lamps with carbon lamps. The results were, it seems, rather unfavorable to the type of metallic-filament lamp employed—the tungsten lamp—but this may be explained by the fact that they were compared with thirty-two-candle-power carbon lamps. The comparison was entirely fair, since the tungsten lamps had a higher candle-power than the carbon lamps, but, of course, the thirty-two-candle-power carbon lamps would naturally show less variation than sixteen-candle-power lamps of the same efficiency. This comparison was made by direct observation. A further examination was, however, made stroboscopically to determine the actual variation in luminous intensity during the cycle, and a comparison was made in this way of a number of carbon-filament lamps. The result shows that in general the more efficient the filaments the greater the variation at low frequencies, but, as the frequency increases, the curves approach, and that for a high-efficiency filament may fall below the curve for one of lower efficiency. A very interesting feature of these curves, showing variations in luminous intensity, is the sharp bend which takes place between twenty-five and thirty cycles. The variation in luminous intensity was found to decrease rapidly with an increase in frequency up to twenty-five cycles. Beyond this point the decrease is much slower. This, as pointed out by Dr. Sharp, suggests that if thirty cycles or thereabouts should be adopted for power circuits that the conditions are very much more suitable for direct incandescent lighting.

It might be in some cases that a frequency of thirty cycles would, in the end, be more economical than transmission at lower frequency, and then conversion to a higher one or to direct currents; for while the alternating currents might require the use of less efficient lamps to produce equally satisfactory results, they would still save the losses due to transforming apparatus, besides giving a simpler system. For example, one of the curves given in Dr. Sharp's paper shows that a 3.1-watt lamp has a maximum variation of thirteen per cent on thirty cycles, while a metallized-filament lamp has a variation of about twenty-three per cent. However, the curves also show that the curve for the 3.5-watt lamp lies between the other two. In other words, a considerable gain in steadiness is secured by substituting for the metallized filament lamp a 3.1-watt lamp. But a change from 3.1 to 3.5 watts makes matters worse again. Curves for carbon lamps rated at eight candle-power had the same general characteristics as those for sixteen-candle-power lamps, but, as is to be expected, the variation of these thinner filaments is considerably greater for the lower-efficiency lamps. There seems to be little effect upon the high-efficiency lamps, such as the metallized filament. A similar curve for a tungsten lamp rated at thirty-five candles, one and one-quarter watts per candle, is much flatter. There is apparently a slight bend a little below twenty cycles per second, but the variation in luminous intensity is considerably greater than that of the carbon lamps, as it is thirty-seven per cent at twenty-five cycles, thirty-two per cent at thirty cycles, and even at forty cycles has only fallen to twenty-two per cent.

The study is of much interest and importance, since it calls attention to a phase of the lighting problem a further study of which may bring forth valuable results.

ELECTRICITY.

It is an interesting fact that the newer theories of electricity bid fair to restore that old and significant term to its original important position. For the past twenty years this word has been avoided by physicists and engineers who have made a study of the branch of physics designated by it, and left to the popular writer and the layman. This avoidance has been due to a feeling of the unsuitability of a term which implies an entity when referring to something which the initiated prefer to consider energy. The distinction is here made between matter and that which enables matter to do work, and the latter is called energy, though, of course, the mere designating by a distinctive term is not an explanation. But the newer ideas carry us back to the older ones. In the electron theory, electricity is really treated as though it were a form of matter, and we have been taken back to the old fluid theory, modified in important ways so as to agree with more recently acquired knowledge. The new school therefore feels no compunction in speaking about "electricity," for it actually thinks of it as small particles, very mobile and capable of exerting powerful forces. It feels no need of adding the saving clause, "a current of," an expression which is not intended to be taken literally by those who use it, but simply as implying a certain condition.

But, in acquiring this old word and all that it implies, the inheritance is not an unmixed blessing, for, unfortunately, the current of electricity as now thought of flows in the direction opposite to that indicated by all our symbols and terms. It is a negative current flowing from points of low to points of high potential—a current which goes uphill, as it were, against the direction of motion of what we call positive materials in the electrolytic bath. It is unfortunate that the early investigators found it more convenient to take glass as a positive generator, rather than sulphur, for their thoughtless choice has resulted in a condition which is very puzzling to students and others who attempt to adapt their notions to the new theories.

There is one point in the new theory which is not yet sufficiently clear. While it may be entirely proper to speak of particles of electricity or of "electrons," is this electrical particle believed to be indestructible? Is it conceivable that, to use the old phrase, they may be discharged? If so, then what? Are the effects they produce due simply to their motion, or would they be the same if the particles could be nailed down, so to speak? Is the new school simply carrying us back one step further, and is electricity simply finely divided matter in a peculiar condition which we do not as yet know how to change?

The Use of Storage Batteries in the Electric Lighting of Steam Passenger Equipment.

By J. R. Sloan.

IN a successful system of electric lighting of passenger cars in steam-railroad service, the storage battery is an essential portion of the equipment, regardless of the particular system of lighting which may be used, if a perfect service is to be rendered.

Perfect service implies that there shall be available at all times a sufficient volume of current to meet the demands that are made, and that this current be supplied at the predetermined voltage.

While it is true that there are electrically lighted trains on various railroads which do not include storage batteries as a portion of their electrical equipment, nevertheless, the above holds true, and should the train be broken up after nightfall to cut a car in or out, some other source of illumination, such as gas, must be depended upon if a battery be not used.

This situation also occurs at division points where the locomotive is changed, although the difficulty may in this case be overcome by connecting the train to the local electric plant and throwing a change over-switch.

With any system of so-called axle-generators, or generators which are driven by power transmitted from the car axle, a storage battery is necessary, as it provides the only means whereby power may be obtained while the car is at rest, or running below the "cutting-in" speed.

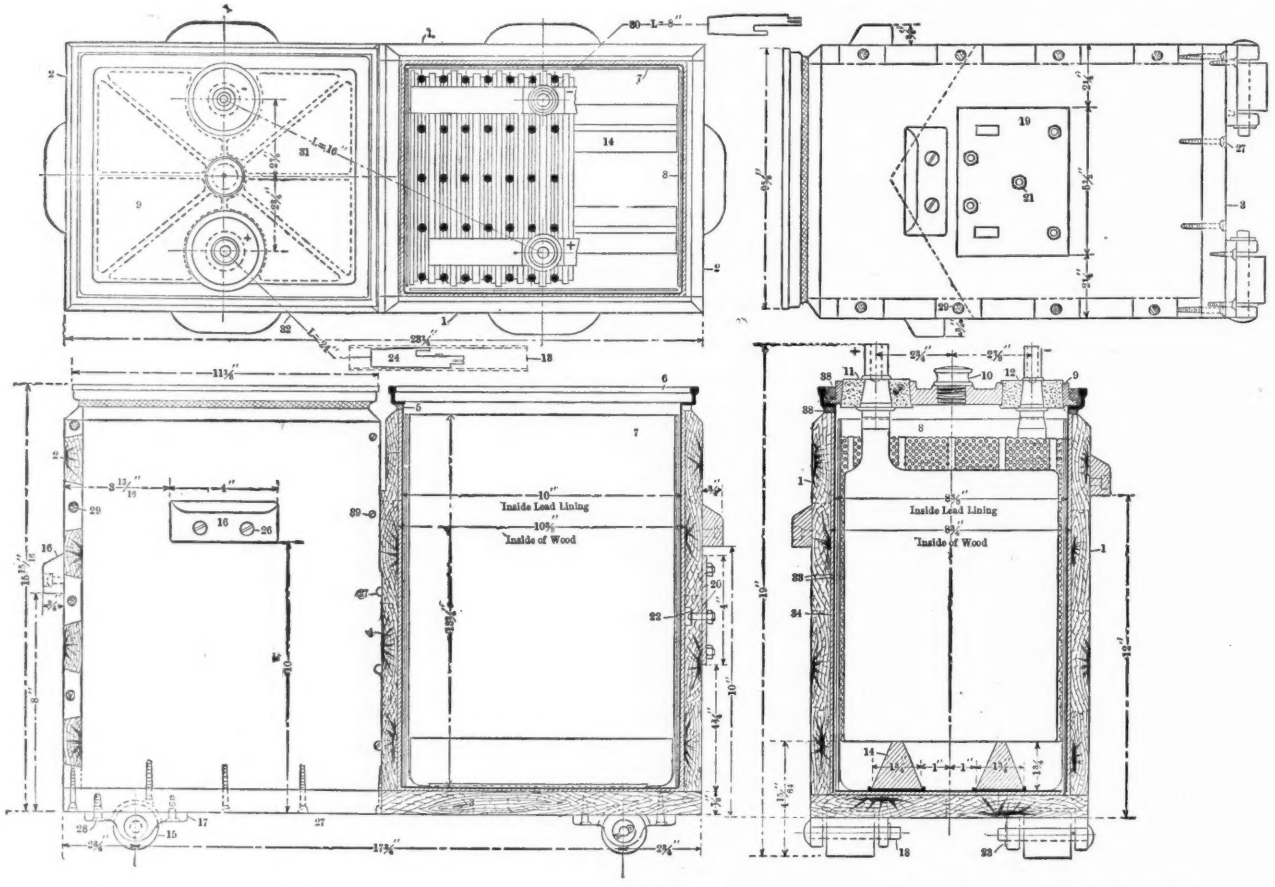
At the present writing, batteries are used in this service in the following ways: "straight storage," and in conjunction with axle and steam-driven generators.

"Straight storage," as the term would indicate, means that all the current used *en route* is obtained directly from the battery. The battery is charged at the terminal points of the car's run, either by charging while in place on the car, or by removing the exhausted set and replacing it with a fully charged set.

If charged while on the car, the lay-over must be sufficiently long to permit the batteries to be charged from the yard plant, and the yard master must also "spot" the car so that it may be connected to the yard outlets. If the batteries are exchanged it is necessary that the yard master leave openings so that the cars may be readily accessible. The labor involved in changing is considerable, while the continual handling results in a more rapid deterioration of the elements.

The necessity of "spotting" the cars or making the openings and then leaving them undisturbed is a cause of great inconvenience to the yard master, especially in a congested yard.

When batteries are used in conjunction with steam-driven generators, past practice has been to float them across the line in parallel with the lamps. As the lamps must be of such a voltage that they will burn normally when the battery dis-



THE USE OF STORAGE BATTERIES IN THE ELECTRIC LIGHTING OF STEAM PASSENGER EQUIPMENT. (SEE TABLE ON PAGE 921).

charges, it follows that during all the time lamps are burning the generator can not be operated at a voltage sufficient to fully charge the batteries, as this would result in blackening the lamps, thus decreasing their candle power and materially shortening their life, due to high voltage.

On the other hand, were the generator operated to produce normal voltage at the lamps, the output of the machine would be reduced to such an extent that it would not pay to run it, because the batteries, being electrically so much nearer the load, would assume it, and, if they were fully charged, might even drive the generator as a motor; or, if the line was provided with underload or reserve current-breakers, open the breaker in an attempt to do so.

On account of the above conditions, it is customary when lamps are burning to operate the generator at a voltage which is a compromise between the two extremes, so as to give about eight per cent excess voltage at the lamps, allowing the battery to carry a portion of the load. While this results in a more or less blackening of the lamps and shortening of their life, the principal objection from an operating view is that in case of failure of the generator or inability of the locomotive to supply steam, the batteries are not fully charged and, in consequence, a failure of lights may result.

The ideal system of electric train lighting would be one which would permit the generator to carry the full lamp load at normal voltage, and at the same time permit the batteries to be fully charged, thus ensuring an adequate reserve of power to carry the load, in case of failure of the generating apparatus or of the locomotive to furnish steam, and also obviating the necessity of expensive terminal plants.

When the writer first entered the field of electric train lighting, the batteries in use were much smaller in capacity than are now generally used, and were floated across the mains as above described. They were used in open-top hard-rubber jars, with hair-pin or ring separators, with bolted connections. These jars were placed in wooden crates, four or six to a crate, and adjacent cells were connected by means of flexible rubber-covered wire with lead ends which were bolted to the battery terminals.

On account of the open tops, the shock of coupling the cars and the vibration while *en route* would cause the electrolyte to splash over, soaking the wooden crates. This, and the electrolyte carried off by the evolution of gas while charging, would result in the batteries becoming heavily grounded, and the loss of electrolyte would necessitate frequent attention to maintain it at the proper height and of the correct specific gravity. In many cases this grounding was sufficient to cause a hole to be burned through the jar.

The many bolted connections were also a source of serious trouble, it being seemingly impossible to maintain a good connection, while the brass bolts and nuts, though lead-covered, were soon corroded by the acid. Also on account of having to scrape the battery terminals and connector lugs, so as to obtain clean and fresh contact surfaces, each time the battery was overhauled, the terminals soon became very weak and broken connections at these points were frequently found.

REFERENCE TABLE FOR TANK EQUIPMENT SHOWN ON PAGE 920.

No.	Piece.	Name.	Material.
1	2	Tank sides	Wood
2	2	Tank ends	Wood
3	1	Tank bottom	Wood
4	1	Tank partition	Wood
5	2	4 lbs. lead lining	Lead
6	2	Cover frame	Lead
7	4	Rubber side lining	Hard rubber
8	4	Rubber end lining	Hard rubber
9	2	Covers	Hard rubber
10	2	Vents	Hard rubber
11	2	Positive terminal bushing	Sponge rubber
12	2	Negative terminal bushing	Sponge rubber
13	1	Connector sleeve	Soft rubber
14	4	Bottom insulators	Porcelain
15	4	Rollers	Porcelain
16	6	Buffers	Porcelain
17	4	Roller bracket, Patent No. V, 5024	M. I.
18	4	Roller bracket spindles	Steel
19	1	Hook plate	Steel
20	5	¼-inch button-head bolts	W. I.
21	5	¼-inch nuts	W. I.
22	5	¼-inch washers	W. I.
23	4	½-inch cotter pin	W. I.
24	1	Westinghouse connector, male	Brass
25	1	Style No. 11,557, female	Brass
26	12	No. 10, 1-inch round-head wood screws.	Brass
27	26	No. 10, 1½-inch flat-head wood screws.	Brass
28	16	No. 14, 1-inch flat-head wood screws.	Brass
29	32	3-16-inch wood dowels	Wood
30	1	No. 6 flexible R. C. wire, L-8-inch	..
31	1	No. 6 flexible R. C. wire, L-16-inch	..
32	1	No. 6 flexible R. C. wire, L-24-inch	..
33	..	Petrolyte	..
34	..	Paraffine	..
35	..	Paint	..
36	..	Solder (hard)	..
37	..	Solder (special low melting)	..
38	..	Sealing compound	..
39	8	No. 6, 1½-inch flat-head wood screws.	Brass

On account of the separator used, dead cells were a common occurrence, due to the active material bridging the space between the plates.

The loss of active material on these early batteries was excessive and the mud space was entirely inadequate, so that it was found necessary to thoroughly clean the battery about every three months.

All of these conditions militated against the battery and as a consequence their life was short, the depreciation averaging about twenty-five per cent per annum.

The first improvement was the substituting of a ribbed, perforated, hard-rubber sheet separator for those of the hair-pin or ring type, and this materially decreased the number of short-circuited cells. As the breakage of the hard-rubber jars was excessive and the price was continually increasing and had reached a figure that was considered exorbitant, recourse was finally had to lead-lined wooden tanks. At first these tanks were constructed with an open top, and consequently soon developed grounds in the same manner as had the open-top rubber jars. The consequences, however, were more serious, as electrolytic action of the lead lining set in and much trouble was encountered by reason of leaky tanks. As otherwise the lead-lined tanks were giving good satisfaction, it was thought that if the tanks were to be fitted with tight covers and insulated by being placed on porcelain rollers, with porcelain buffers around the sides, the trouble would be overcome. Designs embodying this idea were accordingly prepared, a cover of indurated fibre, contained in a malleable iron frame, and provided with a hollow square rubber gasket, being used, the whole held in place by "U" shaped rods passing under the bottom of the tank and through holes in the cover frame, wing nuts being used to draw the cover down tightly in place.

Where the "U" rods passed underneath the tank they were supported either by the roller brackets or by shoes so as to prevent them cutting into the wooden tank.

A soft-rubber bushing was provided for the battery terminals where they passed through the cover for the double purpose of insulating them and making the tank acid-tight.

The bolted connection was also discarded, and instead the flexible rubber-covered wire was soldered directly into the terminal of the battery, a special low-melting solder being used for this purpose.

The mud space at the bottom and the free-acid space at the top were also greatly increased.

These tanks, constructed as above described and when new and carefully assembled, entirely overcome the "grounding" of the battery and the resultant electrolytic action on the lead linings.

However, after these tanks had been placed in service it was found that the indurated fibre would disintegrate under the action of the acid, and that the rubber

gasket was neither wide or thick enough to make a perfectly tight joint.

It was also found that the iron cover frames and "U" rods were being corroded, necessitating frequent renewals of these parts.

Accordingly a sheet-rubber gasket, with the soft-rubber bushings for the battery terminals forming a part of it, was designed and wood, boiled in paraffine, was substituted for the indurated fibre. This materially improved conditions and the trouble with the iron parts corroding was considerably reduced. It was still, however, serious enough to entail considerable expense of labor and material. It was, therefore, decided to abandon the use of iron on the tanks, with the exception of the roller brackets and pins and the hook-plate, at the same time preserving the tight-cover feature. An entirely new design was therefore prepared.

The lead lining, which heretofore had been of pure rolled lead, was made of antimony lead and burned at the top to an antimony-lead casting. This casting was so constructed as to act as a reenforcement of the top edges of the tank and at the same time form a rest for the cover.

The cover was made of a flexible hard-rubber compound of a special composition, capable of withstanding a great deal of misuse without breaking.

The battery-terminal bushings were made of sponge rubber, and extra large, so as to permit the effects of any shock to be absorbed without placing either the terminals or cover under stress.

The cover was sealed in the antimony-lead top casting with a compound of petrolyte, coal tar and lamp black, made of a consistency readily workable at ordinary temperatures, and which did not run at the higher or become brittle at the lower temperatures to which it would be subjected.

It had been the custom to paint the outsides of the linings and the insides of the tanks with petrolyte as a further precaution against electrolytic action, but when the first lot of the tanks built as above described were made, it was found that if this practice were followed that the petrolyte adhered so strongly to the lining that it was impossible to remove it. The design was therefore altered to allow a clear space on all sides of one-sixteenth-inch between the lining and the tank.

When assembling the tanks, molten paraffine was poured into the wood tank to a depth of about two and one-half inches and the lining plunged while the paraffine was still hot. This caused the paraffine to rise and fill this clear space, and the lining was readily removable by simply filling same with hot water, so as to again melt the paraffine.

Tanks constructed in this manner have been in service for approximately a year, and have been carefully watched, and as yet there has been no cause for complaint, they having all the good points of the first closed-cover tanks without their disadvantages.

Special attention to the design of batteries for electric lighting of passenger equipment has been given by several companies manufacturing batteries and the results have been very gratifying.

Where formerly short-circuits and broken connections were frequent they are now a rarity, and where it was necessary to clean the batteries every three months we now find it possible to defer the first cleaning for from fifteen to eighteen months, and make the subsequent cleaning about every twelve months.

Trouble is still occasionally encountered due to "growing" and "buckling," but in almost every instance this can be traced to improper treatment of the battery.

This improper treatment is, in many cases, impossible to avoid, on account of the conditions under which the batteries are operated, but if discovered in time and the proper precautions taken, its ill effects can be almost completely overcome.

It is believed that the improvements noticed in the operation of batteries are due to three causes: First, a decided improvement in the battery itself due to a better understanding of the conditions of service on the part of the manufacturers, and improved design of the elements due to better knowledge of the internal stresses undergone by the battery. Second, the use of improved separators, and third, the improvements in the tanks as exemplified in the increased mud and free-acid space, tight covers and better insulation.

Where formerly the average rate of depreciation per annum was about twenty-five per cent, authentic records are extant of batteries which have been in continuous service in excess of four and one-half years and are still above their normal capacity and in excellent condition.

It is the writer's belief that with the batteries now being furnished the average depreciation will not exceed fifteen per cent and may possibly be as low as twelve per cent.

The use of wood separators, except where the active material on the positive is in very bad condition and the negatives are low in capacity, is not considered to be good practice. Under these circumstances the wood separators may be used and will tend to hold the active material in place and will increase the capacity of the negative.

The following specifications for train-lighting batteries have been drawn up after consultation with prominent battery manufacturers, and thought to represent the type of cell which is best suited to this work.

SPECIFICATIONS FOR 280-AMPERE-HOUR CAR-LIGHTING BATTERIES.

These specifications, together with blue prints from tracings which are made a part of same, cover a 280-ampere-hour car-lighting battery.

BATTERY SET.

Each set of batteries shall consist of the following:

Thirty-two positive elements, each made up of six (6) positive plates, connecting strap and terminal post.

Thirty-two negative elements, each made up of seven (7) negative plates, connecting strap and terminal post.

Three hundred and eighty-four perforated hard-rubber-ribbed separators.

Note—All plates and terminal posts must be thoroughly and securely burned to their respective straps.

BATTERY ELEMENTS.

The plates composing the battery elements shall preferably be made from pure rolled lead, electrochemically formed.

Both positive and negative plates shall be ribbed in a uniform manner, and there must be sufficient reserve lead in the ribs to ensure a reasonable life without due loss of capacity. These batteries must be designed for use in the double-compartment lead-lined tanks with hard-rubber covers, as shown on prints from the tracings above mentioned.

CAPACITY.

Each complete element shall have a capacity of at least 280 ampere-hours, discharging at a thirty-five-ampere rate, with the cell at a temperature of seventy degrees Fahrenheit, and the time at which the voltage has fallen to 1.8 volts per cell being taken as the end of discharge.

CADMIUM READINGS.

The voltage in any one cell at end of discharge between cadmium and positive must not be lower than 1.98 volts. The voltage between cadmium and negative, at the same time, must not be higher than 0.20 volts.

ACTIVE MATERIAL.

The active material must be uniform in structure and it must be present in sufficient volume and with sufficient surface to give the desired capacity.

SEPARATORS.

Separators are to be made of hard perforated rubber, at least one-thirty-second-inch in thickness and provided with vertical ribs of the proper size to space the plates the correct distance apart.

TANKS.

When batteries are ordered with double-compartment lead-lined tanks, the tanks must be built in accordance with the prints from the company's tracings Nos. ——.

METHOD OF SHIPMENT.

The batteries shall be shipped in their respective tanks, the plates covered with acid and in a fully charged condition, both batteries and tanks being complete and ready for immediate service upon being removed from the crate in which they are shipped.

If positive or negative elements only are ordered they shall be shipped "knocked down," and in such condition that after being

"set up" they will be ready for service after having had one full charge.

Whether shipped in tanks or "knocked down" they must be securely crated that they may not be damaged during shipment, except that when shipment is made in carload lots, the crating may be omitted, provided that the tanks are so loaded that they will not shift while in transit.

CHARGE AND DISCHARGE RATES.

Normal charging rate	amperes	hours
Maximum safe charging rate	amp. start	amp. finish
Normal discharging rate	amperes	hours
Maximum discharging rate	amperes	hours

POSITIVE AND NEGATIVE PLATES.

	Positive.	Negative.
Thickness of finished plate	.....	.....
Number of plates per cell	6	7
Weight per square foot of plate	17	12
Weight of one plate with lug	.....	.....
Thickness of ribs or projections forming the support for active material	.....	.....
Number of ribs per inch	.....	.....
Size of cross-bar or bridge	1 3-4″ × 7-16″	
Size of plate	.....	.....
Thickness of centre web	.....	.....
Ratio of active to superficial area of plate	.....	.....
Per cent of total weight of positive plate available for the electrolytic action to disintegrate before the plate loses fifty per cent capacity	.....	.....

ELECTROLYTE.

Pounds of acid required for one cell	.....	.....
Specific gravity at end of charge	.....	.....
Specific gravity at end of discharge	.....	.....

NOTE—Bidders will kindly fill in the space left blank above.

The advantages which electric light possesses over other forms of illumination which have been used heretofore in such service in the way of less heat and vitiation of the air, decreased fire hazard, more effective illumination and the possibility of designing more artistic fixtures, are patent to all.

For the Preservation of Niagara Falls.

On November 26 Secretary of War Taft entertained at Washington, D. C., representatives of American and Canadian water-power interests and representatives of the American Civic Association. Arguments were made for and against the admission into the United States of electric power generated in Canada from the waters of Niagara river. Under the Burton Act for the preservation of the scenic beauties of Niagara Falls, passed at the recent session of Congress, the secretary of war is vested with the right to grant rights, within certain limitations, for the importation of power and also for the diversion of water from the river from the American side of the stream.

J. Horace McFarland, president of the American Civic Association, contended that the Burton Act specifically charged the secretary of war with the duty of preserving the scenic features of the falls, and that it was passed solely in response to the insistence of the American people that the diminution of the waters of Niagara river for power purposes should cease. He pointed out that while the act limited the diversion and indicated the limitations as to the amount of power which may be transmitted from Canada, it expressly provided that these limitations should not be construed as a direction to the secretary of war to issue permits for the diversion of water or the importation of electricity. He urged that the paramount duty of the secretary of war under the act was to see that nothing was injured or interfered with the scenic beauty of the falls. He contended that the admission of any power generated on the Canadian side is fully equivalent in its effect upon the scenic advantages of Niagara Falls to an equal diversion in the United States.

Mr. McFarland opposed any importation of power in his opening statement, but later in the day said that it was possible that the present importation of power might not impair the falls, and that he might not oppose the bringing in of 157,500 horse-power, as recommended by Captain Charles W. Kutz, of the Army Engineer Corps, who made an investigation of the matter at the direction of Secretary Taft last summer, if there could be any positive assurance that there would be no demand for additional permits. He opposed the importation of 360,000 horsepower, the amount which is sought by the various Canadian companies interested.

Clinton H. Woodruff, secretary of the American Civic Association, closed the argument for the protesting party, contending that the complete preservation of the falls could only be accomplished by international agreement, and that to grant permits for the importation of power from Canada would be to so firmly entrench the power companies that it would be impracticable, if not impossible, ever to reach an international agreement upon the subject.

The opening argument for the industrial interests along the Canadian frontier was made by W. Caryl Ely, of Buffalo, N. Y. Mr. Ely said that the commercial interests, manufacturers and population had vastly increased since the beginning of the use of Niagara for power purposes, and that part of the state would be greatly handicapped by the withdrawal of this power. He declared that the refusal to grant permits for the importation of power from Canada would be construed as an affront to the Canadian government, from which the companies had obtained their right to utilize the waters of the river, and from which the Canadian government derived a revenue. Besides, he said, the companies which had spent from $20,000,000 to $25,000,000 in developing power in Canada would, if forbidden to import power into the United States, develop a market for the power in Canada, which would operate greatly to the detriment of interests in New York state.

Francis L. Stetson, representing the Canadian Niagara Power Company, made an emphatic argument in reply to Mr. McFarland. Mr. Stetson took Mr. McFarland to task for his "sentimentality," and characterized many of his statements as untrue. He stated that the subtraction of water sufficient for 360,000 horse-power would make no appreciable difference in the scenic beauty of the falls. Mr. Stetson denied Mr. McFarland's statement, that the Canadian companies were seeking to form a monopoly which would control all the power generated on the other side, and asserted that the companies were in considerable of a quandary as to their relative possibilities for distribution of power. With regard to the cost of power, he stated that electricity in the Niagara Falls radius costs about one-fourth as much as in Philadelphia or New York, and that there was a greater demand for power than could now be supplied. No international agreement for the preservation of the falls could be reached by an action indirectly seeking to control the Canadian side of the river by prohibiting the importation of power. Such an attempt would be resented by the Canadian government, which derives a revenue from the power companies for its grants.

General Francis V. Greene, representing the Ontario Power Company, made a brief statement urging the granting of the permits. Aside from the fight which the companies are having with the American Civic Association on the question of transmitting power across the river, the companies are in serious controversy among themselves as to the division of the power. The Canadian Niagara Power Company and the Schoolkopf Companies, the pioneer concerns to develop power in Canada, claim the right to import all the power permissible under the Burton Act.

TRANSFORMATION OF ELECTRIC POWER INTO LIGHT.[1]

BY CHARLES PROTEUS STEINMETZ.

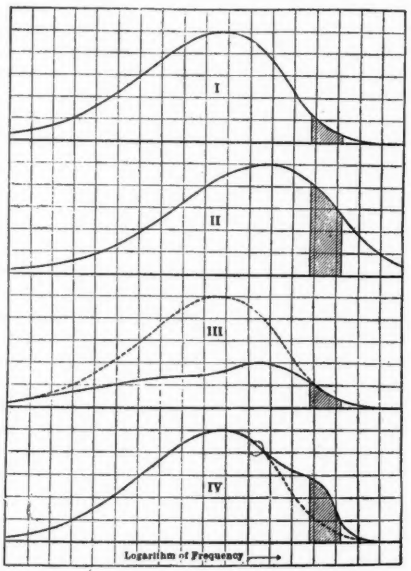
If energy is impressed upon a solid or a liquid, as by passing an electric current through a carbon filament, and no other work done, the body is heated. This energy must be given off again; it is given off partly by conduction, but largely by being radiated from the incandescent body. By increasing the power, the amount of radiation increases; and there are changes in the quality of the radiation, too: first appear radiations of very great wave-length or very low frequency, then, with the increasing power, higher frequencies appear; that is, the wave-length of radiation becomes shorter.

Of the infinite variety of waves radiated by a heated body—from the long heat waves given by liquid air to the shortest ultraviolet waves, many octaves of wave-length in all—somewhat less than one octave is visible to the eye. These wave-lengths are useful as light; the rest is wasted energy.

Of these useful rays, the visible three-quarters of an octave, none appears until the temperature is fairly high. Below that only the long waves appear. That means the average wave-length of radiation decreases with the temperature. Or, with increase of temperature, not only the existing waves become intense, but shorter and shorter waves appear, and the intensity maximum moves toward a shorter wave-length. With increase of temperature the percentage of visible radiation thereby becomes greater and ultimately reaches a maximum, or the efficiency would be the highest when the maximum intensity lies just within the visible octave. Where this maximum may be is unknown, but it is beyond the temperature of the crater of the arc, possibly somewhere between 4,000 degrees and 5,000 degrees centigrade. At that temperature the efficiency of the incandescent light is a maximum, and probably from one-quarter to one-half watt per candle-power. But even then the efficiency is not high, five to ten per cent, or thereabouts. It follows, however, that even if we could raise the incandescent body to the temperature of maximum efficiency, we would still get only about five to ten per cent of all the energy as light. The other ninety per cent would be ultra-violet, chemical or actinic rays, X-rays or long heat-waves. There is thus an absolute limit to efficiency of lighting by incandescence.

The higher the temperature the greater the light efficiency of an incandescent body. Carbon is apparently the most refractory of all substances—its boiling point being somewhere near 3,500 degrees centigrade, so an incandescent body, at the highest possible temperature, and the incandescent crater of the carbon arc are the most efficient sources of light by incandescence. They are still somewhat below the temperature of the efficiency maximum.

Incandescent lighting is effected by the electric current, either by raising the temperature of the light-giving solid body, a lamp filament, by passing a current through it or by passing the current from it into another body. In the latter case



VARIATION OF RADIATION WITH CHANGE IN FREQUENCY.

the temperature of the boiling point of the material is reached, and the crater of the carbon arc lamp is at the highest temperature which can be reached; gives it an incandescent light of maximum efficiency probably not very far from half a watt per candle-power. But the large amount of energy which is conducted away by air currents, etc., greatly reduces the actual efficiency of the carbon arc below this value.

When producing light by passing an electric current through the conductor, as in the incandescent lamp, no such efficiency can be reached. Here carbon is also chiefly used. The higher the temperature of the incandescent-lamp filament, the greater is the efficiency; but the limit of the temperature is not the boiling point of carbon, 3,500 degrees centigrade, but far below that; it is the temperature where evaporation of the filament becomes so rapid as to limit its life below economical requirements. This is probably not very far from 1,800 degrees centigrade. Far below the boiling point, evaporation takes place: water evaporates at ordinary temperatures; even below the freezing point snow and ice evaporate very noticeably. An incandescent carbon filament evaporates, thereby decreasing in cross-section, and increasing in resistance; the current decreases, therefore the temperature decreases and with the temperature the efficiency decreases. As the condensed carbon vapor blackens the globe and obstructs the light, another decrease of light results from absorption. Thus efficiency has to be sacrificed in the incandescent lamp to get good life, and the specific consumption of electric power, instead of being one watt per candle-power (as in the case of the arc lamp) becomes as high as four watts per candle-power.

The arc, then, is the more efficient illuminant. But its efficiency is still low, and here there has been a similar result; to increase the life, the efficiency has been decreased by enclosing the carbon arc, in the present long-burning lamp. Increasing the efficiency of the arc by reducing the conduction of heat by a decrease of the diameter of the carbon has also been tried, with the same result—exchanging efficiency for life.

In the incandescent lamp the problem of increasing the efficiency can be attacked in two ways. One way is to replace the carbon by a material which has a lower vapor-tension at high temperature. While carbon has the highest boiling point, it is not the boiling point which is of importance in a lamp filament, provided that this point is sufficiently high—it is the vapor-tension, far below this point.

The efficiency of the incandescent lamp can be improved by replacing the carbon filament with a material which has a lower vapor-tension and a sufficiently high melting point. Tantalum, osmium, wolfram or tungsten as materials for incandescent lamp filaments promise to revolutionize the incandescent lamp by holding out fair promise of an ultimate efficiency of about two watts per mean spherical candle-power for tantalum, 1.5 watts for osmium and one watt per mean spherical candle-power for wolfram—compared with about four watts per mean spherical candle-power for the carbon-filament lamp. The objection to these metal filaments obviously is the low resistivity inherent to metals which restricts their use to rela-

[1] A paper presented at the two hundred and fourteenth meeting of the American Institute of Electrical Engineers, New York, November 23. Slightly condensed.

tively larger units, or at least makes difficult the production of low-candle-power sizes.

Another way of improving the efficiency of the incandescent lamp is by improving the carbon. The vapor-tension depends not only on the chemical constitution, but also on the physical structure. At the boiling point of carbon the carbon deposited from hydrocarbons converts, under the influence of atoms which can enter and leave the carbon chain, into an allotropic modification having pronounced metallic characteristics, as elasticity, a positive temperature coefficient of resistance, etc., and very great stability, so that as a lamp filament this form of carbon can be run up to a considerably higher efficiency, in the so-called "metallized filament."

Most incandescent bodies give the same, or approximately the same, law of radiation, that of the so-called "black body"; that is, at the same temperature the intensity of radiation varies with the wave-length or frequency in the same manner, somewhat similar to that shown by Curve I, Fig. 1[1], with a maximum at a certain wave-length. At higher temperature, Curve II, a similar intensity curve exists, with the maximum at shorter wave-length, or higher frequency, so that the intensity within the visible range, shown shaded in Fig. 1, is a higher percentage of the total radiation—that is, the efficiency of light production is higher.

If, however, a body could be found which at the temperature corresponding to Curve I gives an abnormally low radiation outside of the visible range, as illustrated by Curve III, or which with normal radiation in the invisible range gives an abnormally high radiation in the visible range, as illustrated by Curve IV, then in either case the visible radiation would be a greater percentage of the total radiation than corresponds to the temperature, that is, the efficiency of light production would be higher than that of a black body at the same temperature. Theoretically such a body with selective radiation might give an efficiency higher than the absolute maximum of light efficiency of black-body radiation.

Either of the two cases, abnormally high radiation in the visible and abnormally low radiation in the invisible range, may give the same shape of intensity curve, the only difference being that in the first case the total radiation per unit-surface is higher, in the last case lower than that of a black body at the same temperature. That is, with the same amount of light radiation and the same efficiency, in the last case the radiating surface is greater than in the first case, and this may give a criterion to decide between the two alternatives.

With such selective radiation there is a distribution of intensity throughout the visible range, and so the color of the light may differ from that of an incandescent body. With abnormally high radiation in the visible range, the increase of intensity is probably greatest in the middle of the visible spectrum; with abnormally low radiation in the invisible, the decrease of intensity is least in the centre of the visible spectrum. In either case the tendency is towards preponderance of the wave-lengths in the middle of the visible spectrum; that is, the greenish-yellow, as characteristic of such selective radiation, and apparent in the Welsbach mantle. Typical of such selective radiation is the lime cylinder of the calcium light, and possibly the flame of burning magnesium.

With gas as illuminant, a very great increase of efficiency has resulted from the use of selective radiation, as found in the Welsbach mantle.

In electric lighting, the Nernst lamp probably represents the first attempt on a large scale of improving the efficiency of light production by selective radiation. It has not been as successful as in gas lighting, since the efficiency of the Nernst lamp does not differ much from that of the carbon incandescent lamp, while the efficiency of the Welsbach mantle is many times higher than that of the ordinary gas flame. The reason probably is that with a very inefficient illuminant, as the gas flame, the additional light given by selective radiation may increase the total light several fold, while the same amount of additional selective radiation with a relatively far more efficient illuminant, as the incandescent lamp, is a far lower percentage of the total visible radiation. Or, to illustrate, the additional shaded area between the dotted and the drawn line in Curve IV, Fig. 1, increases the efficiency threefold, while the same additional area added to the shaded area of Curve II would not materially increase the efficiency. That is, the increase of efficiency by selective radiation of an incandescent body becomes less with a more efficient illuminant, and selective radiation may greatly increase the efficiency of inefficient illuminants, but not so much that of efficient illuminants, so that the hope of very greatly increasing the efficiency of light production by selective radiation of solids does not appear very strong. However, some of the recent very efficient incandescent lamp filaments, as tungsten and osmium, may owe their high efficiency partly to selective radiation; that is, they give light not only by incandescence but also by luminescence.

The problem of efficient light production consists of producing radiations; that is, vibrations of the molecules or atoms of the light-giving body, of frequencies within a limited narrow range, that of a visible radiation, and as few vibrations as possible outside of this range. When heating a solid body, the energy put into it as heat sets the molecules or atoms in motion, in vibration. Where they are close together, as in a solid or liquid, they can not vibrate freely; each can not have a period of its own, just as all the different grains in a sand heap can not vibrate simultaneous as do the molecules of a tuning fork, and the vibration is irregular. All you can get is a mixture of all kinds of vibrations, not a tune, but a noise. To get a tune requires a body which can vibrate freely without restraint; that means a gas; as the gas molecules are free they can execute free vibration. A vibration of a definite pitch, definite frequency, that is, definite color of light, can be produced only in a gas or vapor. But when heating a gas or vapor, the energy put into it appears not as vibration of the molecules, except perhaps indirectly at extremely high temperature, but as rectilinear motion or pressure. The molecules move faster in their rectilinear paths, and so strike the boundary at higher velocity; the pressure of the gas rises by increasing molecular velocity; that is, increasing temperature, but the vibration of the light radiation does not appear. So heat, while making a solid or liquid incandescent, does not make a gas incandescent or luminous but merely increases its pressure.

There are methods, however, of setting the gas molecules in vibration. By chemical reaction or electric stress, gases become luminescent; that is, the molecules of the gas are set in vibration. For instance, if the gas is used as a conductor of electric current, then the molecules of the gas are set in vibration, and we find a definite period of vibration, or a number of periods or frequencies, in which the gas molecules or atoms can vibrate; that is, gases give line spectra. Here results a definite rate of vibration, practically independent of the temperature. For in-

[1] These curves, drawn with the logarithm of the frequency of radiation as abscissas, are only illustrative, and not quantitative nor based on experiment, but merely illustrating the statements made above.

stance, in mercury vapor the lowest frequency is that giving the greenish-yellow line, but no appreciable amount of vibration is so slow as to give red light at ordinary temperature. When you raise the temperature very high (but still below the temperature of the incandescent lamp filament) then the mercury molecule begins to execute a slow vibration, which gives an intense red light, and red lines appear in the mercury arc; with increasing temperature it gradually changes its color from green to white to red. Here we have a particularly interesting illustration that for luminescent vapors or gases the law of the black-body radiation does not apply.

As a rule, then, it can be said that such an arc or a luminescent gas or vapor is more efficient as a producer of light the lower the temperature. This is just the reverse of the solid incandescent body.

Theoretically, there is no limit to the efficiency of a luminescent vapor. A vapor may be imagined which vibrates only with one particular wave-length, say a yellow line. That means all the energy put into it must be radiated at that particular wave-length, as yellow light, and therefore the conversion of electric energy into light would be 100 per cent, not counting the energy lost by heat convection or conduction. The latter can be made very small by enclosure in a vacuum. Complete conversion of electric power into light would so result, if all the spectrum lines were within the visible range. That is never the case. There is no definite law giving the percentage of energy which appears as radiation in the visible spectrum, and which appears outside of the visible range as ultrared and ultraviolet lines; but the position of the lines in the spectrum is an individual characteristic of the gas or vapor. The problem of efficient light production is to find a material having most lines in the visible range of the spectrum.

With mercury vapor which is set in vibration by the current, a very high percentage of the total energy is radiated in the visible range. With carbon vapor, the percentage of energy radiated in the visible range is extremely small. The carbon arc is extremely low in efficiency, practically non-luminous. Silicon also gives a practically non-luminous arc. Others, like calcium, titanium, etc., give a very high percentage of light within the visible range and so a high efficiency of light production.

The color of light produced by incandescence varies from reddish-yellow at low temperature to yellow, and approaches yellowish-white at higher temperature. Selective radiation of solids tends to superpose hereon a preponderance of greenish-yellow rays, without, however, greatly changing the color. With electroluminescence of vapors and gases, however, the color of the light depends on which of the spectrum lines happen to be most prominent.

Electroluminescence makes it possible to produce light of any color. This, however, greatly complicates the question of efficiency. As efficiency can no longer be considered the ratio of the power radiated within the visible range to the total power input, since the different parts of the visible spectrum have entirely different energy-equivalents: one candle-power of red light or of violet light represents many times more power, which issues as radiation, than one candle-power of green or of yellow light. That is, the light-equivalent of power is a function of the wave-length. It is obviously zero in the ultrared, it is very low in the dark red, and gradually rises to a maximum in the yellow and green, and then decreases again, becoming very low in the violet and zero in the ultraviolet. One candle-power per watt as red light or as violet light may therefore represent a fairly high efficiency, while ten candle-power per watt, with green or yellow light, would be a far lower efficiency. That is, the energy radiated in a beam of one candle-power red light probably is greater than the energy of a beam of ten candle-power of green light.

This feature explains the impossibility of determining efficiencies of light by the measurement of physical quantities. Light is the physiological conception of some wave-lengths of radiation, but no physical quantity.

Where high economy of light production is the only or the foremost consideration, spectra in which green or yellow preponderates are therefore selected; for instance, as mercury, bluish-green in the mercury arc lamp, or calcium, yellow in the flame-carbon lamp. These two illuminants give high efficiency, but they give it by sacrificing the inefficient colors at the end of the visible range. But, unfortunately, the sun, as an incandescent body, gives the light of solids or liquids, and therefore gives all the radiations, with the red end of the spectrum specially prominent; and, since we call the sun white, the light from the mercury arc appears green, that of the flame carbon arc yellow, not the yellow of the incandescent lamp, but a pronounced monochromatic hue.

The mercury arc and the flame carbon arc are useful for cheap lighting, regardless of color. They also find an application for special effects due to their color. So the mercury arc is eminently suited for outdoor lighting in suburban districts where its effect on foliage and snow makes it superior to illuminants containing red rays, and so intensifying the appearance of incipient death in the vegetation, and where the intrinsic brilliancy of illumination can be kept sufficiently low as not to show the objectionable effect of monochromatic light. The flame carbon arc finds its field in advertising, where its intense glare makes it especially suitable.

For general illumination, at least in this country, people have become educated to require as close an approach to daylight as possible; that is, to require white light. The problem, then, is to find a vapor which gives spectrum lines over the whole visible range, distributed approximately in the same manner as the intensity in the solar spectrum, and giving as few lines as possible outside of the visible spectrum.

A substance giving spectrum lines uniformly distributed in their intensity over the whole visible range should not give white, but a pronounced green light, due to the higher physiological effect of the radiations in the middle of the spectrum. By the law of probability, amongst the spectra of the chemical elements, the predominant intensity of radiation should be found just as often in one wave-length as in any other. Physiologically, therefore, green should predominate in the colors of metal spectra. To a certain extent this is true. Red metal spectra are rare, green most prominent. Bluish metal spectra, however, are much more frequent than should be expected by probability, and it therefore seems that in molecular vibrations of vapors, shorter wave-lengths or higher frequencies predominate. This may be due to the size and mass of the molecules being such as to have a mean frequency of oscillation higher than the average frequency of visible light.

(To be concluded.)

American Institute of Architects.

The next convention of the American Institute of Architects will be held in Washington, D. C., January 7, 8 and 9, 1907. This will commemorate the fiftieth anniversary of the institute, which was founded in 1857. A bronze memorial tablet containing the names of the founders will be unveiled in the Octagon, commemorating the occasion. During this meeting the institute will inaugurate the custom of presenting a gold medal for distinguished merit in architecture. The first medal will be presented to Sir Aston Webb, the architect of the Victoria Memorial, London, who received the gold medal of the Royal Institute of British Architects and knighthood during the past year. A formal banquet will be held, at which will gather those distinguished in the fine arts, prominent government officials, representatives of educational institutions and men of literary fame.

POLYPHASE SYSTEMS OF GENERATION, TRANSMISSION AND DISTRIBUTION.[1]

BY M. A. SAMMETT.

Every electrical development possesses some typical peculiarities which should be the determining factors in the selection of the frequency of the system as a whole, as well as the selection of the generating and distributing systems as to phases, that is, whether it should be two or three-phase.

Whatever the generation and distribution, the transmission of power is always accomplished by three-phase. This arrangement allows of most economical transmission of power with a given drop in the line. While the transmission of power is invariably accomplished by three-phase, the generation and distribution is often by two-phase. A two-phase system for distribution purposes is somewhat simpler to operate than a three-phase system. The two phases may be controlled independently for single-phase lighting circuits without any appreciable effect of one phase on the other. In the case of motor connections on two-phase circuits, all that is necessary is to connect the two transformers with the primary coils to the line, and the secondary coils to the motor. No special attention is required as to polarities of transformers. The impedance of transformers need not be the same for proper division of load, as is essential in connections of three-phase installations.

Power-House—Taking up the generating plant first. For a given capacity, speed and voltage, at a given frequency, the three-phase generator will prove the more efficient machine.

At the switchboard the only advantage the two-phase board has in comparison with the three-phase, is the saving of one ammeter. It is standard practice to use an ammeter in each leg, therefore the three-phase board will require three ammeters. It is also maintained that the figuring of the kilo-volt-amperes load from the instruments is a more difficult matter with a three-phase than with a two-phase installation. The above objections have very little weight when compared with the advantages of a three-phase board.

All bus-bars, oil-switch contacts and switch compartments, all cables from generators to switchboard and from the board to the transformers are reduced, in the three-phase system, in the ratio of four to three, but a 15.6 per cent larger cross-section of copper is required.

[1] A paper read before the electrical section of the Canadian Society of Civil Engineers, November 15. Condensed.

The use of but two transformers for a given load allows a greater individual transformer capacity, and therefore a more efficient transformer. This would have been a decided advantage, favoring the two-phase system, were it not for the fact that the transmission of power is to be by three-phase. To accomplish this phase transformation by the well-known Scott connections, unless all transformers are provided with a heavier high-tension winding, the transformer capacity would of necessity be reduced, due to a higher current in the three-phase winding, namely than of 115.6 per cent of the normal current. Should, however, the transformers be designed with provision made for this higher current, it would necessitate larger transformers, or in other words, a more expensive installation. Beside this increased transformer capacity, another disadvantage must be added, that of a possible resonance, with T-connected transformers for two-phase-three-phase transformers. Whenever one of the phases is open, due to a failure of making proper contact of various switches or any of the auxiliary connections, the high reactance of the high-voltage transformer will be in series with the capacity of the transmission line and a resonance is likely to take place.

The advantages of using a three-phase generator are further augmented by the possibility of using transformer connections, with which the danger of resonance is eliminated. Of the transformer connections in vogue, there are two which are free from the danger of resonance, namely delta to delta for step-up and delta to delta for step-down, or delta to Y and Y to delta. While the delta to Y and Y to delta is selected for transmissions where highest voltages are made use of, the delta to delta and delta to delta gives the most reliable service. With the latter style of connections, should one of the transformers fail, as soon as this transformer is cut out the service may be restored. This latter connection, namely delta to delta and delta to delta, which insures both continuity of service and freedom from resonance, is introduced now on one of the 60,000-volt transmission lines and is destined to become the standard, inasmuch as high-tension transformers for 60,000 volts as well as the insulators, especially if the latter are carefully selected and tested, have the requisite factor of safety.

Distributing System—The considerations which hold true in the discussion of the transmission line will also hold true in the distributing system. The three-phase delta connections should be made use of, since on motor service a complete shutdown due to a failure of one transformer must be carefully guarded against. Again, the three-wire, three-phase distribution will result in a saving of twenty-five per cent of copper and insulators. It will reduce the maintenance expense by the same percentage.

The advantages thus enumerated show clearly the desirability of three-phase distribution from the purely commercial standpoint and still more so from the point of view of reliability and permanency of supply. Some engineers object to the three-phase distribution on the ground of the difficulty of balancing loads. With a mixed load of lighting and power, the power load has an equalizing tendency on the balancing of the system and with some attention given to the proper division of the connected lighting load, no difficulty will be encountered.

The comparative losses of two and three-phase motors of the same rating are as follows:

A two-phase machine should have twenty-two per cent more conductors per slot than the corresponding three-phase Y-connected machine, designed for the same voltage and flux per pole.

The magnetizing current is the same in both the two and three-phase machines when expressed in percentage of the current, which corresponds to the full-load output.

The copper loss of the two-phase machine is twelve per cent higher than that of the three-phase.

The leakage factor of the two-phase machine averages twenty-five per cent greater than that of a three-phase machine, therefore the power factor is lower. Actual results show from one to three per cent lower power factors.

These considerations show that the two-phase machine will have a higher temperature rise as a result of a higher copper loss. For the same reason the efficiency of the two-phase motor will be lower. The slip of the two-phase machine will also be greater. Tests and theoretical calculations show twenty per cent greater slip.

Thus the two-phase induction motor is a poorer motor for the central station company, due to a poorer power factor. It is also less advantageous to the power user, due to the lower efficiency. The higher temperature rise will result in a shorter life and larger slip will mean a greater fluctuation between synchronous, partial and full-load speeds.

While the three-phase service should be made standard, two-phase motors may be

used by the aid of three-phase-two-phase transformers. This, however, should be discouraged, as such transformers require special taps, which make them more expensive, especially so when core-type transformers are used. It also means the carrying of a stock of these special transformers as spare units.

Frequency—The frequencies most widely used on this continent are those of sixty and twenty-five cycles. As far as the transmission line is concerned, the lower the frequency, the less the inductive drop, the smaller the charging current and the better the regulation. As a purely transmission problem the twenty-five-cycle frequency would be adopted. The problem, however, is more complicated. The transmission line is only a chain in the link, and important as it is, it should not overrule the advantages of a higher frequency as applied to the distributing end of the system.

The table of speeds of generators at sixty and twenty-five cycles shows a wider range of speeds, hence a greater flexibility when laying out a sixty-cycle hydroelectric power-house. The speeds of turbine-generator units are limited by the number of wheels, type, head and output. Therefore the wider range of speeds permissible with a sixty-cycle system will enable the selection of the most efficient generator-wheel combination. Inasmuch as increased peripheral velocities will result in a decrease in active material, the selection of higher speeds will enable one to choose cheaper hydroelectric sets. The above conclusions hold true except when higher speeds call for special construction, which will rapidly increase the cost.

The switchboard under the two frequencies is unaffected. All meters and potential and current transformers are designed for satisfactory operation on frequencies from twenty-five to 125 cycles.

Transformers built for twenty-five cycles are much more expensive, as well as less efficient, than when built for sixty cycles. Considering that there is with a generation, transmission and distribution of power a total transformer capacity equivalent to from three to four times the capacity of the generating apparatus, one will readily see the advantage of the higher frequency.

With incandescent lighting thirty cycles is the limiting frequency, and forty cycles is unsatisfactory when moving objects are viewed. On this continent sixty cycles is the standard frequency for such a service, while fifty cycles is European practice. For arc lighting forty cycles is the limiting frequency. Lower frequencies may be made use of in the application of the recently developed mercury vapor converter and magnetite lamps.

Analyzed from the standpoint of frequency, induction motors show characteristics which make it difficult to decide as to the best motor. Both motors under careful design can be made of equal performance as to power-factor, efficiency, etc. But the motors will be of radically different designs. From the commercial standpoint the sixty-cycle motors have a decided advantage, namely, a somewhat higher speed. Speed and cost are inversely proportional, hence the sixty-cycle motor will prove the cheaper of the two. Another point which favors the sixty-cycle motor is the greater demand for it, and the manufacturing companies have developed a finer design of this frequency. As a rule lower-frequency motors are adaptations of standard sixty-cycle frames and punchings, hence their performance does not show characteristics of the same high standard. Of course the low-frequency motors have advantages of their own, such as better starting torque, higher instantaneous but not continuous overload capacity and lower speeds. As stated before, unless the motors of the lower frequency are standardized for best and most efficient design the high-frequency motors are more satisfactory.

The principal factors in favor of the sixty-cycle motors are better continuous overload capacity and also a cheaper product commercially as a result of higher speeds. Therefore, with equally good performance as to efficiency and heating, the sixty-cycle motor will still be ahead of the twenty-five-cycle motor.

The suitability of low-frequency synchronous converters for railway work is a well-established fact. While sixty-cycle synchronous converters are used for such purposes, they are rather an exception and their operation is less satisfactory. What should then, under the circumstances, be a desirable way of supplying street railway loads without resort to frequency changers? The latter are out of the question, due to excessive cost, beside the great reduction in the efficiency of the systems, resultant from their use.

Motor generator sets may be and are advantageously used in this connection, and while not possessing the advantages of twenty-five-cycle synchronous converters, have features which make them particularly suitable for use on long-distance transmission systems, as they permit of a partial or complete control of the power-factor of the system. Wherever large capacity is present, due to long transmission lines, induction motor generator sets of large size can be used to great advantage. For perfect control of the power-factor of the transmitted power, synchronous motors should be employed, as in this case the regulating of the field excitation allows of a close control of the power-factor of the transmitted energy.

While the synchronous converter is the most efficient of the three means of supplying railway loads, whenever this load constitutes only the minor portion of the total output of the plant, the interests of the lighting and power load can not be sacrificed.

The preceding discussion leads to the conclusion that for a mixed load of lighting and power with a railway load not exceeding one-third of the total power generated, sixty cycles will be the frequency to select.

Charging Current and Line Regulation—The charging current and the regulation of the line, under adverse conditions, will limit certain developments, making them impossible, commercially considered, at sixty cycles. The same development at twenty-five cycles may present a very attractive proposition using power for a different application. As an example, what will be the relative magnitude of the charging current and the regulation for the line given below at the two frequencies? The values are obtainable from any table of line constants.

Line 100 miles long.

Load 10,000 horse-power for each transmission circuit.

Conductor, 4.0.

Voltage at receiving end, 50,000.

Space between conductors, sixty inches.

Charging current at sixty cycles, twenty-three amperes.

Charging current at twenty-five cycles, 9.6 amperes.

Regulation at sixty cycles, 100 per cent power-factor, full load, nine per cent; eighty per cent power-factor, full-load current, twenty-three per cent.

(Step-up and step-down transformers included in this calculation.)

Regulation at twenty-five cycles (including transformers), 100 per cent power-factor, full load, 5.5 per cent; eighty per cent power-factor, full-load current, ten per cent.

The regulation and capacity or charging current are decidedly in favor of the twenty-five-cycle transmission. The results for the sixty-cycle system, while considerably in excess of those at twenty-five cycles, are considered quite normal for com-

mercial purposes and inasmuch as the increase and decrease in the load is gradual the regulation is well within control of the central station operators or automatic devices.

As to the railway load, this had better be carried on a separate circuit, whenever a multiplicity of circuits is used in transmitting the power.

Considering the successful operation of one of the long-distance transmission lines of 150 miles in California where the charging current forms forty per cent of full-load current, and where the regulation is forty per cent at full load, eighty per cent power-factor, one need not hesitate to operate a line with a regulation of twenty-three per cent, eighty per cent power-factor.

The power-factor of the system, however, is to a large extent within the control of the operating company, as it may recommend to power users such apparatus as will best answer the purposes of the system as a whole. Beside this, by employing synchronous motors running as rotary condensers, it will be enabled to regulate the power-factor of the system and keep it if necessary at unity. These synchronous motors running idle, used supplementary to the synchronous motor generator sets, will allow of a perfect control of the power-factor of the system, reducing the regulation to nine per cent under full-load condition.

The author concludes that under the conditions as stated, for a mixed lighting and power load, with a railway load not exceeding thirty-three per cent of the total output, a three-phase, sixty-cycle system should be employed throughout and all transformation should be accomplished by delta to delta connections.

Production of Electrical Machinery in 1905.

A bulletin (No. 57) just issued by the Bureau of the Census, of the Department of the Interior, Washington, D. C., gives the accompanying statistics showing the production of electrical machinery during 1905.

The following figures show the extent and character of the power used by the manufacturing industries.

Mechanical power of some variety was used in 134,520, or 62.2 per cent, of the establishments included in the census of manufactures in 1905. The inclusion of the neighborhood and mechanical industries at prior censuses greatly reduced the proportion of establishments reporting the use of power. Of the 512,254 establishments reported at the census of 1900, only

ELECTRICAL MACHINERY, APPARATUS AND SUPPLIES—PRODUCTS, BY KIND, QUANTITY AND VALUE: 1905 AND 1900.

	1905.	1900.
Products, total value	*$159,551,402	†$105,831,865
Dynamos:		
Number	15,080	10,527
Value	$11,084,234	$10,472,576
Horse-power	1,328,243	770,832
Dynamotors, etc.	$1,740,534	$379,747
Transformers	$4,468,567	$2,962,871
Switchboards, etc.	$3,766,044	$1,846,624
Motors, all kinds	$22,370,626	$19,505,504
Direct and alternating:		
Number	79,877	35,604
Value	$13,120,948	$7,551,480
Horse-power	678,910	515,705
For railways:		
Number	12,298	15,284
Value	$4,949,795	$7,568,841
Horse-power	713,181	666,669
For automobiles:		
Number	1,819	3,017
Value	$152,685	$192,030
Horse-power	19,907	8,220
For fans:		
Number	102,535	97,577
Value	$1,168,254	$1,055,369
Horse-power	30,796	12,766
For electric elevators:		
Number	1,333	(‡)
Value	$638,473	$2,523,901
Horse-power	13,398	(‡)
Miscellaneous:		
Number	8,481	7,913
Value	$2,340,471	$613,883
Horse-power	36,820	11,392
Batteries, including parts and supplies	$4,243,893	$3,679,045
Storage	$2,645,749	$2,559,601
Primary	$1,598,144	$1,119,444
Carbons	$2,710,935	$1,731,248
Lighting	$1,050,971	$1,263,732
Furnace	$172,454	$10,974
Miscellaneous	$1,487,510	$456,542
Arc lamps	$1,574,422	$1,827,771
Open—		
Number	1,748	23,656
Value	$29,989	$276,481
Closed—		
Number	193,409	134,531
Value	$1,544,433	$1,551,290
Searchlights, etc.:		
Number	1,924	8,283
Value	$114,795	$225,635
Incandescent lamps	$6,953,205	$3,515,118
16 candle-power:		
Number	83,333,285	21,191,131
Value	$4,608,084	$2,910,023
Below 16 candle-power:		
Number	19,779,834	2,906,817
Value	$1,132,011	$308,626
Above 16 candle-power:		
Number	9,598,439	1,222,250
Value	$568,204	$223,534
Decorative and miniature lamps:		
Number	1,584,495	397,432
Value	$644,906	$72,935
Electric light fixtures	$5,305,466	$4,344,599
Telephone apparatus	$15,863,698	$10,512,412
Telegraph apparatus	$1,111,195	$1,642,266
Insulated wires and cables	$34,519,699	$21,292,001
Electric conduits	$2,416,245	$1,066,163
Annunciators	$185,870	$224,885
Electric clocks, etc.	$373,926	$132,149
Fuses and lightning arresters	$1,455,203	$595,497
Rheostats and resistances	$1,328,752	$1,186,878
Electric measuring instruments	$5,004,763	$860,265
Circuit fittings	$3,525,446	(‡)
All other products	§$26,634,963	$15,764,875
Amount received for custom work and repairing	$2,798,922	$2,063,736

* Includes electrical machinery, apparatus and supplies, valued at $18,742,033, made by establishments engaged primarily in the manufacture of other products.

† Includes electrical machinery, apparatus and supplies, valued at $13,397,430, made by establishments engaged primarily in the manufacture of other products.

‡ Not reported separately.

§ Includes $1,451,337 for electric switches, signals and attachments; $678,077 for magneto ignition apparatus, and $1,036,962 for electrical therapeutic apparatus, including spark coils.

169,409, or 33.1 per cent, reported power. The census of 1890, with 355,415 establishments, showed 100,735, or 28.3 per cent, using power, while the census of 1880, with 253,852 establishments, had 85,923, or 33.8 per cent, using power.

Comparatively little motive power is employed in the neighborhood and mechanical industries, and their exclusion from the census of 1905 has but slight effect on comparisons with the statistics for prior censuses in which they are included. The horse-power, by kind, as reported at each census since 1870, is summarized in Table 81. This table gives the total horse-power reported at each census, except the amount returned for custom grist and sawmills and cotton-ginning establishments at the census of 1900.

HORSE-POWER EMPLOYED IN MANUFACTURES, WITH PER CENT OF INCREASE: 1870 TO 1905.

	DATE OF CENSUS.					PER CENT OF INCREASE.			
	1905.	1900.	1890.	1880.	1870.	1900 to 1905.	1890 to 1900.	1880 to 1890.	1870 to 1880.
Total horse-power	14,464,940	10,409,625	5,954,655	3,410,837	2,346,142	39.0	74.8	74.6	45.4
Owned:									
Steam	10,664,560	8,140,533	4,581,595	2,185,458	1,215,711	31.0	77.7	109.6	79.8
Gas	289,514	134,742	8,930	.....	.....	114.9	1,408.9	....	....
Water	1,647,969	1,454,229	1,255,206	1,225,379	1,130,431	13.3	15.9	2.4	8.4
Electric	1,138,208	310,661	15,569	.....	.....	266.4	1,895.4	....	....
All other	91,784	49,985	4,784	.....	.....	83.6	944.8	....	....
Rented	632,905	319,475	88,571	.....	.....	98.1	260.7	....	....

Each variety of power has increased during each census period since 1870. The greatest actual and relative increase occurred between 1890 and 1900. Notwithstanding the great increase in other kinds of power, steam continued to be the motive power of greatest importance.

The use of electric current for the transmission of power has been one of the most notable features of the development of machinery in manufactures. The first census to show electric power was that of 1890, when 15,569 horse-power was reported. At the census of 1905 this class of power owned amounted to 1,138,208 horse-power. When the electric power is generated by the manufacturer the combination of the horse-power of the engines and the motors results in a duplication, but since in some cases the steam engines are used for purposes other than the generation of electric current it is impracticable to avoid this duplication.

Erie Electrification.

Last summer Westinghouse, Church, Kerr & Company were retained by the Erie Railroad to furnish and install upon the Rochester (N. Y.) division a complete equipment of electric motive power covering the passenger service of that portion of the main line of the Rochester division between Rochester and Avon, and the branch between Avon and Mount Morris, a total distance of thirty-four miles of single track, besides sidings. This work has been brought very near to completion. The equipment will represent the most modern type of single-phase, alternating-current system of train propulsion, and will consist of motor-cars of the interurban type.

The supply of power for operating the system will be derived from the lines of the Niagara, Lockport & Ontario Power Company, which receives the current generated at the new station of the Ontario Power Company at Niagara Falls. This power is now being transmitted at 60,000 volts as far east as Syracuse. The power company's transmission line crosses the Erie Railroad at Mortimer, about five miles south of Rochester, and from that point the power company is constructing a branch line about fourteen miles long, which is to supply the substation at Avon.

The substation building is of brick and reenforced concrete, and is now practically completed. The electrical apparatus is being rapidly installed.

The electrical equipment of the cars comprises four 100-horse-power motors, one on each axle, besides the transformer equipment which forms part of the single-phase outfit. Each car will be equipped with the Westinghouse electropneumatic system of multiple-unit train control. The cars will be capable of a maximum speed of from forty-five to fifty miles an hour, and will be able to haul one trailer under any of the conditions of service that are likely to prevail.

The collectors on the car will be of the so-called "pantagraph" type. These are controlled by air pressure and designed to instantaneously adapt themselves to any change in the height of the trolley wire, as when passing under low bridges.

The Electrical Trades Society of New York.

The tenth annual meeting of the Electrical Trades Society of New York will be held on Tuesday evening, December 11, at the Imperial Hotel, Broadway and Thirty-first street, New York city, at 5.30 o'clock. Reports will be read, addresses made and directors will be elected. In addition to the usual proceedings action will be taken on an amendment to the by-laws.

An informal dinner (business dress) will follow the annual meeting at 7.30 o'clock. The dinner tickets will be $3.50 each.

Convention of the Northwestern Telephone Exchange Company.

The second annual convention of the managers of the Northwestern Telephone Exchange Company was held at the general offices of the company in Minneapolis, Minn., November 22, 23 and 24. The opening address was made by H. J. Pettingill, president of the company.

The following papers were read: "Operating Methods," R. F. Estabrook, superintendent of traffic; "Farm Lines," A. von Schlegell, general contract agent; "Requisition and Material Reports," J. L. Barney, supply clerk; "Collections," J. W. Christie, treasurer; "Reports," W. R. Overmire, auditor; "Equipment," J. Houghtaling, superintendent of equipment; "Maintenance," B. Waller, engineer; "Construction," Thomas Dwyer, superintendent of construction; "Connecting Companies," J. L. W. Zietlow.

There were also addresses by C. P. Wainman, vice-president and general manager; C. M. Mauseau, assistant general manager; E. A. Prendergast, attorney; B. L. Freedy, superintendent, and W. A. Stanton, district manager.

A complimentary luncheon was served at the National Hotel on Thursday and Friday; a theatre party was given on Friday evening, and a banquet was held at the Nicollet Hotel on Saturday evening.

Among those present were E. B. Baker, general superintendent; A. Williams, superintendent, and E. C. Short, superintendent of construction, of the Minnesota Central Telephone Company; George A. French, superintendent, and F. E. Lister, district manager, of the Duluth and Mesaba Telephone Companies.

Units and Standards.[1]

As soon as electricity became a science a need was felt for new units—for those quantities which could not be immediately or conveniently expressed in terms of the C.G.S. units of length, mass and time. Resistance, current and electrical pressure had to be measured, and for scientific reasons it appeared advisable to base the new units on the centimetre, gramme and second. There are two ways of doing this, according to whether one started from electrostatic or magnetic phenomena; and we have therefore both electrostatic and electromagnetic units. These two sets of units are, of course, definitely related to one another, but the relation has no practical value, and the individual units of either system are either too large or too small to be of commercial use. Hence the British Association defined what are known as the commercial units, the chief among which are the ohm, equal to 10^9 absolute C.G.S. electromagnetic units; the volt, equal to 10^8 absolute units, and the ampere, 10^{-1} of an absolute unit, and these have been accepted by the civilized world. After definition came the task of making standards, and this is where the real difficulty began. The British Association committee made a standard ohm of German silver wire, but this was subsequently found to be about two per cent less in resistance than the definition required. Siemens had previously used as a "practical ohm" a column of mercury one metre long and one square millimetre in cross-section. This was about four and one-half per cent less than the true value, but the mercury column constituted such a convenient and easily reproducible standard that in revising the value of the ohm, a mercury column was returned to. The Paris congress in 1884 suggested that the international legal value should be the resistance of a mercury column 106 centimetres in length and one square millimetre in area at zero degree centimetre; but this was never acceded to either by England or America, as it was known not to be correct. In 1882 Lord Rayleigh, using the method which had been employed by the British Association committee, of rotating a coil in the earth's field, found the length of the mercury column to be 106.27 centimetres; Dr. Glazebrook, in the same year, arrived at a length of 106.28 centimetres by a different method. In 1891 Professor Viriamu Jones found the value to be 106.3 centimetres, and in the next year the British Association agreed to recognize this value, though defining the mercury as having a mass of 14.4521 grammes and of a uniform cross-section, instead of stating what the cross-section had to be. In 1893 this definition was endorsed by the congress of Chicago, and is now recognized as constituting the international legal ohm.

The standard ohm being decided upon, at any rate, for the present, there remain the ampere and the volt, the determination of either of which, now that the unit of resistance has been settled, will fix the value of the other. At the Berlin congress last year it was resolved that, besides the ohm, the other independent unit should be the ampere, the volt therefore being the pressure which will drive a standard ampere through a standard ohm. The legal standard ampere is at present that current which will deposit silver from silver nitrate at the rate of 0.001118 gramme per second. How nearly such a current approaches the theoretical unit of 10^{-1} C.G.S. is not known; but the difference is probably not great. The volt is, as we have pointed out, dependent on the standard values assigned to the ohm and the ampere; but for convenience an independent legal standard was decided on. The standard volt is such that the pressure across the terminals of a Clark cell at fifteen degrees centigrade is 1.434 volts. This value is certainly not the equivalent of 10^8 C.G.S. units, and it is probable that it would be much more in accordance with the definition of the C.G.S. value of the volt to rate the Clark cell at something like 1.433 volts at standard temperature. This difference, though not much to look at, is of real practical importance. Besides, it is the general opinion that, apart from the inaccuracy of the legal voltage of a Clark cell, this form of cell is unreliable, and the Weston cadmium cell should be adopted as the standard cell.

The state of affairs, then, is something like this: We have the C.G.S. definitions of the ohm, ampere and volt, which are absolute and immutable. They are, however, but abstractions, and there must be physical embodiments of them of the highest attainable accuracy kept as national possessions. These, which may be called primary standards, correspond to the standards of the metre, pound, etc., and must be capable of being copied and compared so exactly that there shall be no observable difference between the primary standards of different nations. When once these primary standards are specified, they must be looked upon as unalterable, and if any discrepancy between them and the C.G.S. units can be detected at any future time, this must be allowed for in exact calculations. The primary standards must be as arbitrary, in that sense, as the metre or the kilogramme, for otherwise there would arise the same confusion as would occur were the standard metre to be altered to conform more closely with the dimensions of the earth. The best primary standard for the ohm is the mercury column, 106.3 centimetres in length. The standard ampere can probably be best defined by the deposition of silver, and the standard volt follows from these two by Ohm's law. As far as primary standards are concerned, there is no need for a standard volt, for the standard ampere can be passed through the standard ohm, and the electromotive force absorbed gives the standard volt.

Every standardizing laboratory in the various countries will, however, require apparatus for verifying or calibrating commercial instruments. Copies of the primary standards will be too inconvenient and costly for this purpose, and secondary standards are needed, suitable for rapid and accurate work. The most convenient resistance standard is a coil of special wire of negligible, or accurately known and constant, temperature coefficient. Again, as the measurement of current by electrodeposition is an extremely delicate and slow process, a more practical instrument than an electrolytic vat is wanted for a secondary standard. Such a standard should probably be some form of the Kelvin ampere-balance, in which the magnetic effect of the current being measured is balanced against the gravitational effect of known masses. Again, a tester can not very well refer to the pressure across the terminals of a standard resistance when a standard current is passing through it every time he requires to compare voltages. He needs some portable cell, such as the Clark or Weston cell, as a secondary standard of pressure, and, of course, one or other of these cells is always used as a volt standard in potentiometer measurements. If a more constant and reliable source of voltage can be found, so much the better.

Now that all nations are agreed as to both the names and definitions of the ideal units of electrical measurement, it is of the utmost importance that some attempt should be made to get an international and permanent agreement concerning the specifications and dimensions of the standards by which the ideals are represented.

[1] Abstracted from *Engineering*, London, November 23.

When once agreement has been arrived at, permanency is, above all things, to be desired. Since the Berlin congress last October experiments have been going on in various countries to determine the best way to define the standards, both primary and secondary. Professor Glazebrook, whose presidential address the other day to the Institution of Electrical Engineers dealt with many aspects of the work of standardization, is responsible for some most exhaustive experiments on the absolute value of the electrical units. The results have not yet been made public, but it is hoped that this work of the National Physical Laboratory will enable both the international ampere and the electromotive force of the Weston cell to be stated with a most extraordinary degree of accuracy. An international conference is to be held in London next October, when we trust that the work of the National Physical Laboratory and kindred institutions abroad will culminate in a universal agreement as to the electrical standards which shall be legalized by the governments of all civilized countries.

Cassier's Magazine.

Cassier's Magazine has been sold by the estate of the late Louis Cassier to Henry Harrison Suplee, for many years technical editor of the *Engineering Magazine,* and James Van Vorst Colwell, recently works manager for the C. W. Hunt Company, and the publication will be continued as heretofore by the Cassier Magazine Company at No. 3 West Twenty-ninth street, New York city. The editorial conduct of the magazine will be in the hands of Mr. Suplee, who brings to this work a wide experience both in the practice of mechanical engineering and of technical journalism, while the business department will be directed by Mr. Colwell. The first issue of the new magazine under the new management will be the January number.

Death of Arthur Vaughan Abbott.

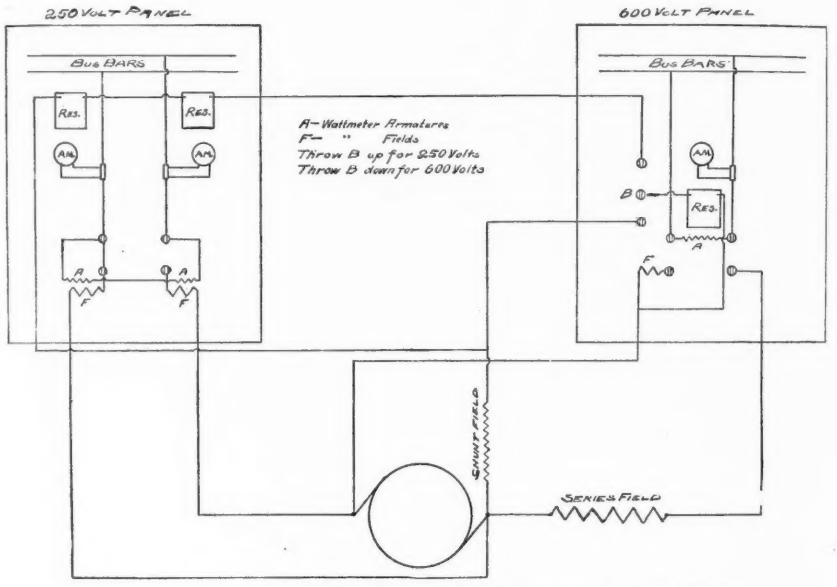
Arthur Vaughan Abbott, one of the most prominently known and esteemed engineers of this country, died from pneumonia, December 1, at St. Luke's Hospital, New York city, after a short illness. Mr. Abbott, who was a son of the late Benjamin Abbott, was born in New York city in 1854. He had been a member of the American Institute of Mining Engineers since 1882, vice-president of the American Institute of Electrical Engineers, and chief engineer of the Chicago Telephone Company and engineer of Westinghouse, Church, Kerr & Company since 1902. He wrote several books. Among his works are "Electrical Transmission of Energy," "The Evolution of a Switchboard," "History and Use of Testing Machines," "Treatise on Fuel" and "Telephony."

Railway Generators Operated on a Three-Wire Lighting Service.

Interesting and valuable results have been obtained by the Topeka Edison Company, Topeka, Kas., in operating a 600-volt railway generator at 250 volts on an Edison three-wire system.

The company has one of the most modern and well-equipped plants in the West. In addition to its regular lighting business it supplies current at 600 volts to the Topeka Railway Company, and for this purpose has installed three 500-kilowatt, 600-volt generators. This number of generators affords a considerable reserve capacity, which is increased by the use of a storage battery which operates on the railway service.

Anticipating an extra heavy demand on the three-wire lighting system during the present winter season, Superintendent J. T. Huntington and Chief Engineer J. L. Chase made the experiment of connecting one of the railway generators to the two outside wires of the three-wire system. To do this the generator was connected to the 250-volt panel in the manner shown in the accompanying diagram. To operate at 250 volts the compounding feature is cut out as indicated, and the field rheostat on the 600-volt panel about one-half cut out; the field resistance is then controlled by rheostats on the 250-volt panel. The engine speed was reduced five revolutions per minute by adding weights to the governor which gave a speed of 120 revolutions per minute. On the day the test was made the generator had operated ten hours at 600 volts and 900 amperes in railway service. In changing over the extra governor weights were added, switch thrown, and the generator connected to the three-wire system at 250 volts, being operated at 850 amperes for over three hours in parallel with regular lighting units. There was no sparking at the brushes and no heating of commutator above normal, and there was no trouble with regulation, which indicates that the amperage could be carried higher. The generator used was a General Electric, type M.P., Class 10, 500 kilowatt, 570 volts, no load; 600 volts full load; 900 to 1,000 amperes, direct-connected to a Buckeye vertical, cross-compound engine with cylinder twenty-three inches by forty-two inches by thirty inches, normal speed 125 revolutions per minute.



Plan Showing Operation of Generator on Either 250 or 600 Volts.

The generator can be changed from either service to the other in a few moments by the adding governor weights, and throwing switch marked "B" in diagram.

Two Exhibitions in Holland.

It is announced by the Maatschappy van Nyverheid, Department Arnheim, Holland, that an exhibition will be held in that city during the month of July, 1907. All letters should be addressed to J. G. van Gelder, 52 Amsterdamsche weg, Arnheim, Holland.

An international exhibition of motors and machines for professions and trades will be held at Amsterdam, Holland, during the months of August and September, 1907. The secretary-general, to whom all correspondence should be addressed, is Dr. Th. Muller Massis, Heerengracht 357, Amsterdam, Holland.

The Entraygues (France) Hydroelectric Plant.

By C. L. Durand.

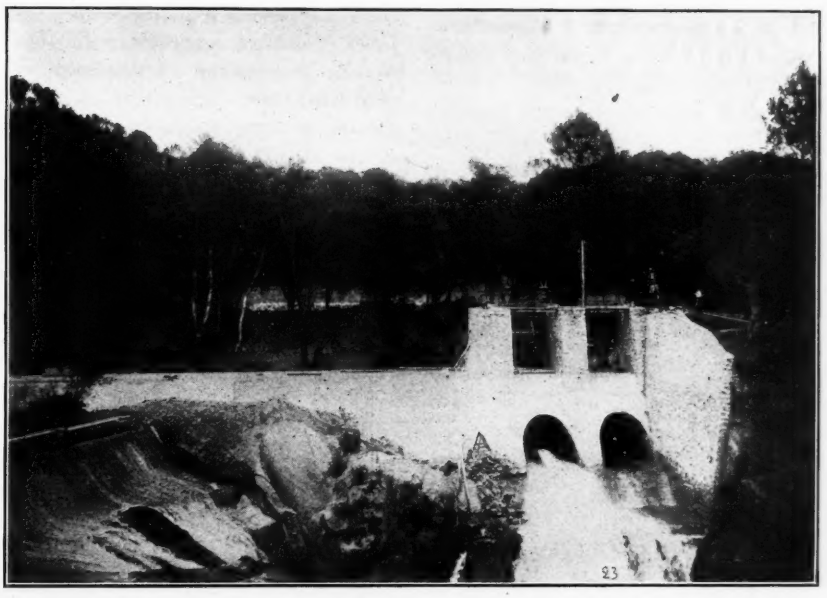
THE mountain streams in the Alpine region of France which lies near the Mediterranean coast have already been utilized for running a number of hydraulic plants of large capacity, so as to secure a considerable amount of current for the cities and towns along the coast, such as Nice, Monte Carlo, Cannes and others. The whole system is connected together, and forms an extensive network of overhead lines working at high voltage. Operated by the company known as the Energie Electrique du Littoral Méditerranéen, these plants form one of the largest hydraulic supplies of the Continent. The electric outfit is supplied by the Thomson-Houston Company, from its Paris shops. Not long ago a new

ENTRAYGUES (FRANCE) HYDROELECTRIC PLANT—A VIEW OF THE MAIN CANAL.

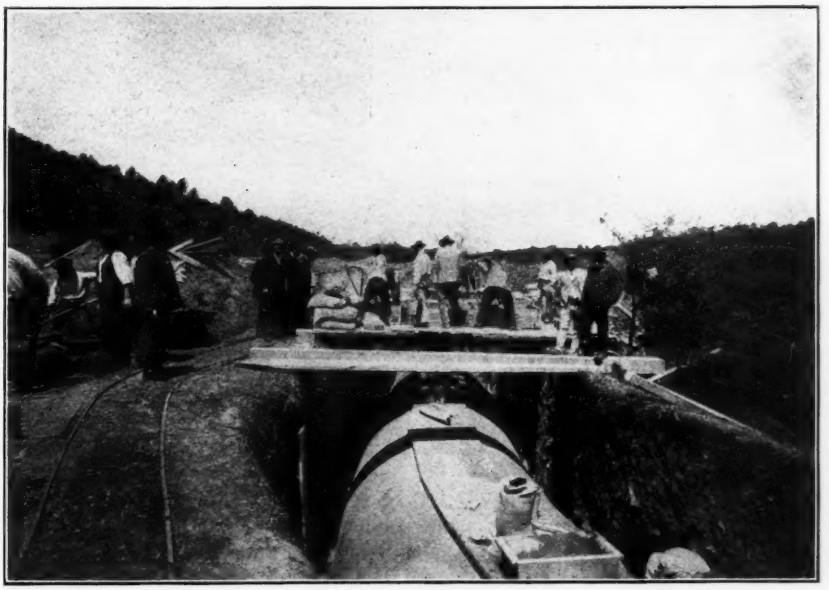
hydroelectric station was erected in the region, and it is one of the most important of the series. The voltage of the overhead line is among the highest which has yet been used in Europe, as it now runs at 28,000 volts. Current is delivered over a thirty-seven-mile overhead line to the city of Toulon, where most of the energy is used at present.

The Entraygues plant has been installed mainly with the object of providing a good supply of current for the lighting circuits and the tramway lines of Toulon, but aside from this, it furnishes a good amount of energy for lighting or motors to numerous villages in the Mediterranean coast region which lie along the path of the high-tension line. It is expected that several large industries in the region of Toulon will also make arrangements to use current from the lines.

Power is obtained from the Argens river, a mountain stream giving a considerable flow, and the hydraulic plant is located at Entraygues, near Vidauban. It utilizes a natural fall in the river followed by a succession of rapids. Between the intake canal at the dam, and the offtake canal at the station the difference of level varies from fifty to seventy feet. The main dam and the hydraulic work in connection with it have been laid out so as to allow of storing up enough water so as to give a good reserve, this being used at times of the day when the lighting current is added to the motor current. The hydraulic work has been carried out by one of the largest Paris construction companies, A. Giros & Loucheur, to whom the writer is indebted for the photographs



ENTRAYGUES (FRANCE) HYDROELECTRIC PLANT—DAM AND HEADGATES.



ENTRAYGUES (FRANCE) HYDROELECTRIC PLANT—MAIN CANAL UNDER CONSTRUCTION.

showing the various parts of the plant. The present views show different portions of the dam, intake canal, piping and penstocks. In the main dam are placed two openings provided with gates, which allow of supplying the canals for irrigation and for water-mills. There are also three outlet gates and the main offtake canal of ten feet diameter. The latter is provided with a gate which is operated by a rack movement, and is protected by an iron grating formed of parallel bars.

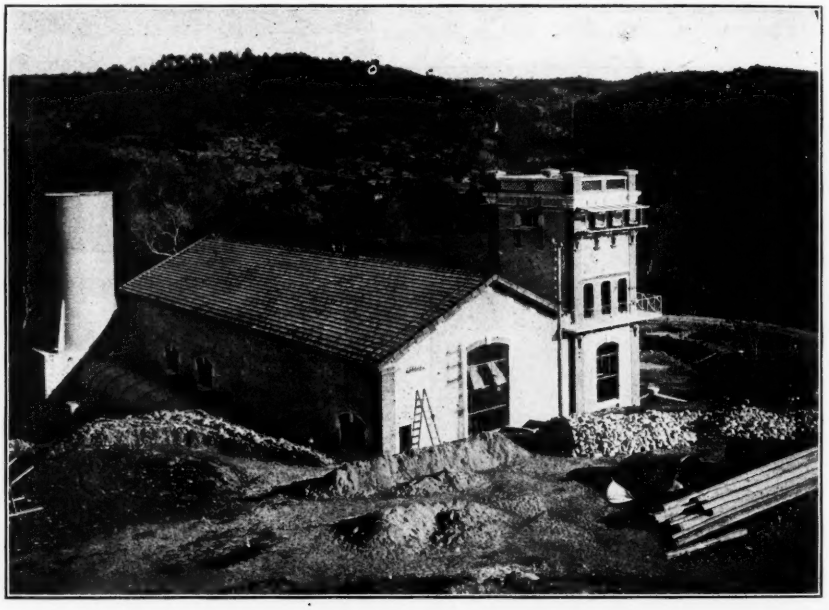
The main canal which passes from the dam to the station is laid underground for the most part, and consists of an eight-inch-thick tube of reenforced cement about ten feet in diameter, working under a water-head which varies from forty feet in times of low water to fifty feet during the freshets. The cement conduit is about 1,600 feet long, and is laid upon a foundation of beton. Its metallic framework consists of soft steel hoops and a set of straight steel bars running parallel to the conduit, these bars being well connected together. A settling basin lies on the path of the canal, and good arrangements are provided for washing it out. When near the station building, the conduit is joined to a steel collector by means of a steel T-piece. This collector has a somewhat larger diameter than the conduit, and is terminated by a vertical stack, held in masonry, which is designed to lessen the pounding in the collector and the conduit at the moment of a quick change in the flow of the turbines, caused by the action of the speed regulators. This vertical stack is about eight feet in diameter, and is surrounded by a second circular stack of sheet steel of about fifteen feet in diameter. When the turbine regulators cut off the water feed suddenly, the water rises in the inner stack and overflows in the outer space, going from thence to the offtake canal by means of steel piping.

In the station there are installed three principal turbine and alternator groups, each of these being composed of a double turbine with horizontal shaft, on the Francis system, coupled to a three-phase alternator. The turbines are designed for 1,000 horse-power, and the alternators for 700 kilowatts. The main turbines utilize a net water-head varying between fifty and sixty-six feet, according to the season, with an aspiration height maximum of twenty-one feet from the level of the dynamo-room to the water level in the offtake canal. The normal running speed of the turbines is 300 revolutions per minute. By means of a belt transmission, the turbine shaft operates an automatic speed governor, and the latter acts through the medium of an oil-pressure hydraulic piston motor upon the water-feed inlets of the turbine, so as to reduce the section of the inflow without causing an interior disturbance. The degree of opening of the inlet and consequently the power given by the turbine, is indicated in a very apparent manner by an index which is connected with the hydraulic piston and is displaced on a graduated scale. The oil which is needed for the working of the hydraulic motors of the station is supplied, at a pressure of fifteen atmospheres, by two triple-action pumps (one of which serves as a standby) worked by electric motors. A special device is used with the turbine which allows of varying their speed within five per cent. This is operated either by hand, or at a distance by means of a small electric motor of special form, worked from the main switchboard.

Each of the main groups is provided with a cast-steel flywheel placed between the turbine and the alternator. The rim of the wheel weighs about six tons and is ten feet in outer diameter. The gate-valves, which are placed under the water inlet of the main turbines, are located outside of the building, but they can be operated from the interior of the station.

Coupled to the turbines by a rigid connection, the alternators are of the revolving-field type. They have ten poles and when running at 300 revolutions per minute, can deliver three-phase current at 3,500 volts, which is the regular working voltage. Should the turbines race and in such case run up as high as 550 revolutions per minute, the alternators are strong enough to support the latter speed without danger.

Separate turbines are used for the exciters. Two sixty-volt direct-current generators (of which one serves as a standby) having a capacity of thirty kilowatts each, run with seventy-five horse-power turbines at a speed of 600 revolutions per minute. Each of these generators is coupled direct to another machine which stands upon the same base-plate and will furnish at least twenty kilowatts at the above speed. These machines are provided with a compound winding which allows the terminal voltage to be kept constant at 110 volts, and are used for the auxiliary service of the plant, and especially for the lighting, independent of the exciter lines, the latter can be operated at a variable voltage, seeing that the simultaneous change of the exciting current for all the alternators is obtained by changing the voltage of the exciter.



ENTRAYGUES (FRANCE) HYDROELECTRIC PLANT—POWER STATION.

The three-phase current furnished by the alternators is sent into the circuits of a bank of three-phase, air-cooled, 650-kilowatt, twenty-five cycle transformers which raise the voltage to 26,000 or 28,000 volts. There are three large transformers used for this purpose, and in fact the station is formed of three units, each consisting of an alternator and the transformer which is connected with it. Such an arrangement allows of a great simplicity in the wiring and the switchboards. An extensive switchboard system

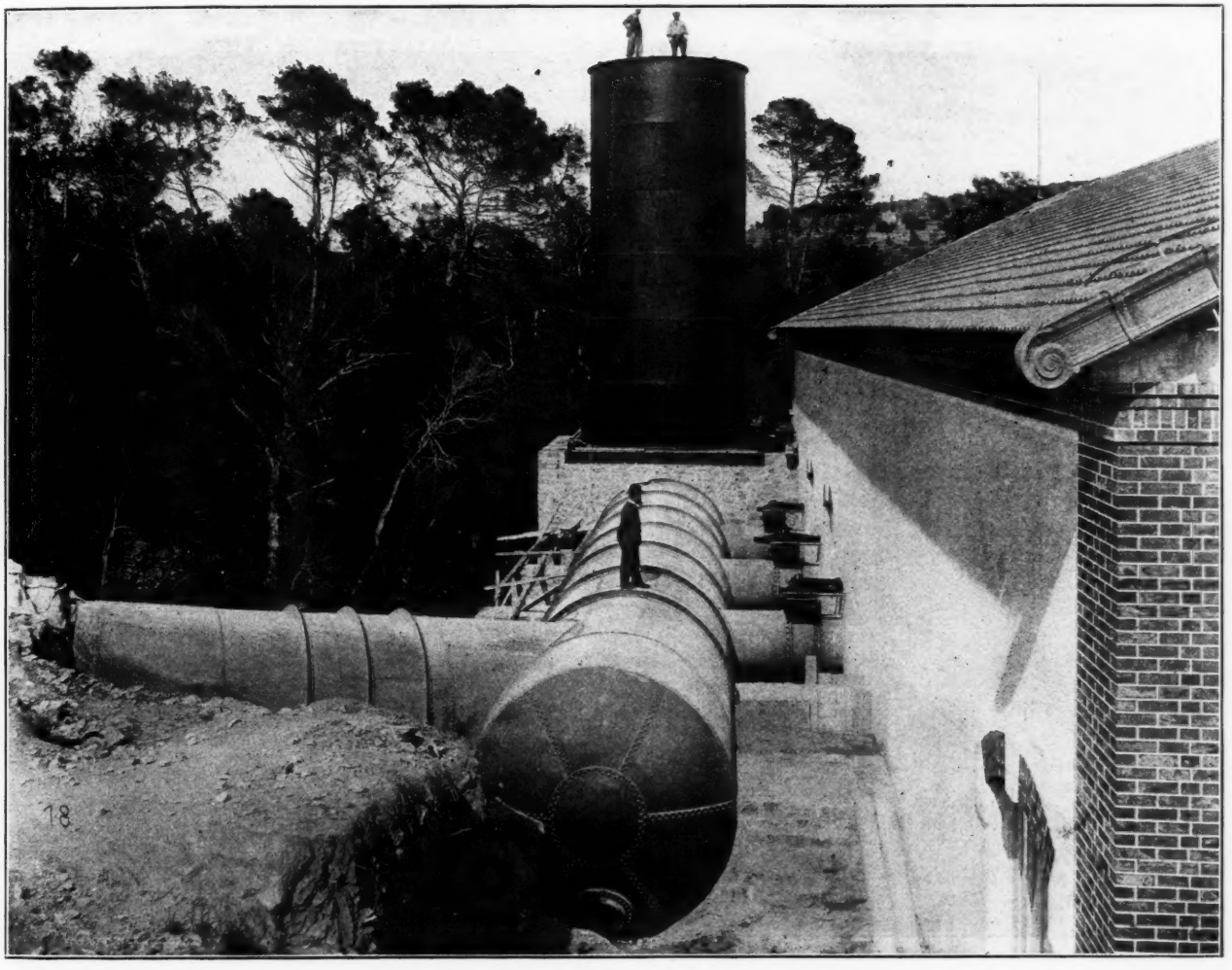
is provided, including a main switchboard containing three alternator panels and one panel each for exciters, auxiliary lines, and station. A second switchboard contains three panels for the low-tension ends of the transformers. There is also a third single-panel board for the switches of the 3,500-volt line.

Each of the main alternator panels has the following apparatus: A three-pole 30,000-volt, oil switch provided with a slow-working relay for an automatic release in case of overload; four knife switches, mounted on porcelain, used for cutting off the main switch from the neutral point of the transformer; a field rheostat; a field switch with shunt resistance for discharge; an ammeter, voltmeter, current meter, power-factor indicator, with their small transformers; one synchronizing plug; a double-throw switch controlling the motor circuit for the regulation of the turbine speed at a distance. The panels for the exciters and the auxiliary circuits each carry the switches, field rheostats and measuring instruments which are needed for handling the corresponding dynamos. The station panel contains one three-pole 30,000-volt, oil switch, four knife switches mounted on porcelain which allow of disconnecting the above and to give an earth connection for the bus-bar, joined to the neutral points; three ammeters, one for each phase; one voltmeter, a Lincoln synchronizer, and a recording voltmeter.

On the auxiliary switchboard, each of the three panels carries three fuse blocks for 3,500 volts, separated by marble partitions; two oil switches of the three-pole type worked by hand and combined so as to form a two-direction switch. They allow of connecting each of the alternators, simultaneously or separately, to the corresponding transformer and to the 3,500-volt bus-bars. The single panel for the switches of the 3,500-volt line leaving the station is provided with a three-pole oil switch with automatic overload break and an ammeter. This line is to supply the region lying near the station. The main switchboard and its appliances are mounted on a metallic platform at one end of the dynamo hall. All the apparatus carried on the outside of the marble panels and which are to be handled by the personnel, are of low tension.

In the Entraygues plant the use of this system of switching has given very good results since starting up the station. The switches have been placed side by side upon a bridge lying near the switchboard. At the bottom the wires enter to the switch by openings in the floor of the bridge. Each of the oil switches is completed by three section switches which allow of cutting it off the bus-bars.

For each phase the bus-bars are formed of a rubber-insulated wire carried upon insulators of the same type as the line insulators, and are separated from the neighboring phase by a horizontal slab of cement. The connecting wires between the three-pole switches and the bus-bars are separated from each other by vertical par-



ENTRAYGUES (FRANCE) HYDROELECTRIC PLANT—PIPE LINE AND HEADER AT STATION.

titions of cement, between which are fixed the knife switches mounted on porcelain which are used for cutting off the bus-bar switches. A gallery running along the end of the station allows of approaching the bars and using an insulated pole for working the above-mentioned knife switches.

Coming from the main three-pole switch corresponding to a line panel, rubber-covered wires lead the current to the windows from which the lines start out to the poles. These windows are placed in a rectangular tower adjoining the main building, which has been laid out for two main overhead lines using six wires each, and an overhead line of three wires working at 3,500 or 10,000 volts.

The overhead line is formed of twenty-eight-millimetre bare copper wire, held upon porcelain insulators of nine-inch largest diameter and weighing 5.8 pounds exclusive of the supports. All the insulators were tested at 100,000 volts during thirty seconds. Straight metal arms fix the insulators to the cross-arms of the poles, the former being spaced about thirty inches apart.

For the local use of the current, a number of substations have been erected at various points on the line, some of these being located at Toulon, and the others between Entraygues and the city. Where the overhead line comes to Toulon, it ends in the transformer post of Brunet, where the voltage is lowered from 26,000 to 3,250 volts by means of two three-phase 650-kilowatt transformers. These transformers are used at the same time for the converting groups of the lighting station of Loubière, belonging to the Société d'Eclairage of Toulon, and for the machines of the tramway substation of Toulon. Two air fans driven by four horse-power, 110-volt motors are used for cooling the transformers, and the motors take current from two ten-kilowatt transformers which lower the current from 3,250 to 110 volts, supplying also the lighting current for the station. The distributing switchboard is made up of two panels for the 650-kilowatt transformers, two panels for the three-phase circuits at 3,250 volts, and one panel for the interior service of the station. Each transformer panel carries three single-pole oil switches for 30,000 volts, with an overload cut-out relay; also four single-pole switches for cutting off the former switches and connecting the neutral point of the transformers to ground, an ammeter, voltmeter, a three-pole oil switch, and a power-factor indicator. Each panel for the 3,250-volt, three-phase line leaving the station contains a three-pole oil switch and an ammeter. One of the panels carries a polyphase meter.

The main oil switches for 30,000 volts are placed separately in brickwork chambers, and are worked together by a mechanism from a single shaft. The latter is operated from the switchboard. An overload solenoid, fed by a relay, allows of making an automatic break for the switches.

Current is distributed from the transformer post just described to the substation of Loubière which supplies the lighting mains of Toulon. The overhead line reaching this point starts from one of the 3,250-volt panels of the Brunet station. In the Loubière substation are placed three motor-generator sets, each containing a synchronous motor of 300

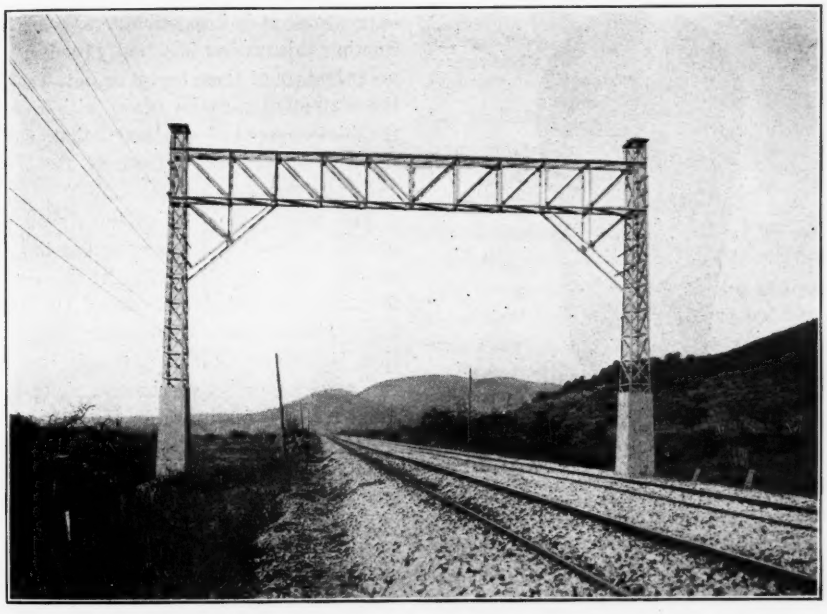
ENTRAYGUES (FRANCE) HYDROELECTRIC PLANT—DYNAMO ROOM UNDER CONSTRUCTION.

horse-power. These motors are of the six-pole revolving field pattern, running at 500 revolutions per minute at twenty-five cycles and wound for 3,250 volts. Direct coupled to the motor is a lighting generator. Each of the three generators is of the six-pole 225-kilowatt pattern, and designed to give 260 volts under full load. Current from the lighting generator is used to excite the synchronous motors. The former are provided with a shunt exciting circuit calculated so that the machine runs regularly for all voltages between a minimum of 240 and a maximum of 300 volts.

A large amount of power is also taken by the tramway substation, which is located at another point. It is supplied from the Brunet transformer post at 3,250 volts, by means of an insulated and armored cable, which supplies two motor-generator groups, each formed by a synchronous motor and a railway generator. The synchronous motor, having fixed field and rotating armature, is of the six-pole type, running at 500 revolutions per minute at twenty-five cycles and 3,250 volts. It is direct coupled to a 225-kilowatt generator, delivering current at 600 volts for the tramway lines. Current for exciting the synchronous motor is obtained from the tramway generator. The latter has a compound winding, and the shunt winding is sufficient in itself to supply the field for obtaining 600 volts at full load. The series winding can be short-circuited when the group works in parallel with a storage battery, and is sufficient to furnish a constant value of 600 volts from the machine. The switchboard of this plant comprises two panels for the synchronous motors, two panels for the direct-current machines and one direct-current feeder panel.

Besides the transformer post of Brunet the Entraygues system operates two posts of less importance, these being placed upon the main 30,000-volt overhead line between the turbine station and Toulon. These posts are near the localities of Gonfaron and Cuers. Both of them are used for supplying light and power to the villages near by. The transformer post located at Gonfaron contains two three-phase, 110-kilowatt, oil-cooled transformers, lowering the line voltage from 28,000 to 3,500 volts. The main high-tension line runs to the inside of the building, and can be sectioned by means of knife-switches placed at two points, between which is taken the circuit of the transformer post. In this way the station can be supplied either from the hydraulic plant or by the line coming from Toulon, in the latter case by means of the reversible groups of the substations which receive direct current from steam-driven generators. These latter groups form part of an old plant, and are retained as a standby.

The Cuers transformer post is equipped with three 250-kilowatt, three-phase transformers, each lowering the tension from 28,000 to 3,500 volts, also three monophase transformers of seventy-five kilowatts which raise the voltage from 3,500 to 10,000. In general, the post is laid out on the same plan as the Brunet and the Gonfaron posts. The high-tension oil switches of the Thomson-Houston pattern are separated by fireproof partitions, being placed on a bridge above the transformers and operated mechanically at a distance. The panels are installed on the main floor beside the transformers. The main high-tension line passes into the station and can be sectioned by an oil switch with hand or automatic action. By means of a set of switches the main line can be short-circuited outside of the station and the latter is thus cut out of the circuit, and means are provided, as in the above-mentioned plant, for supplying it either from the hydraulic station or from Toulon.



ENTRAYGUES (FRANCE) HYDROELECTRIC PLANT—TRANSMISSION LINE.

Capacity of a Battery of Accumulators Operating at Variable Output.

An analytical study has been made by F. Loppé of the proper method of rating storage batteries when operating under a variable output. Peukert has given the following formulæ for rating cells for various outputs: $i^n t = k$, i being the current of the discharge, t the time, n a coefficient depending upon the type of the element, and k a constant depending upon the capacity of the elements employed. This applies to a constant output, but if the load be variable the equation may be written as giving the output for a short time and then integrated over the entire time of discharge. A convenient way consists in plotting the discharge curve, dividing it into triangles, and summing up the areas of all of these. Knowing the value of k it is easy in this way to deduce the proper rating for a battery under any given conditions. The application of this method is shown to a battery having a constant discharge current of 336.5 amperes for ten hours. When the battery is discharged to the same point in the same time, but by varying the currents, the rating is reduced from 3,365 ampere-hours to 2,606 ampere-hours. The same method enables one to determine the charge contained in a battery at any epoch of the discharge.—*L'Industrie Électrique (Paris), November* 10.

NEW TYPES OF INCANDESCENT LAMPS.[1]

BY CLAYTON H. SHARP.

For a number of years the standard of electric lighting has been set by the carbon-filament lamp consuming initially 3.1 watts per candle-power. Progress there has been; but it has been chiefly in the way of minor improvements in the process of manufacture, rating of lamps, and in the way of a more general adoption by electric lighting companies of the 3.1-watts-per-candle lamp. This watt-per-candle consumption has been recognized as the minimum practicable under good operating conditions. Any considerable improvement in the lamp itself has seemed improbable of attainment.

Within the last two years the situation has altered materially. A marked improvement in the process of manufacture of carbon-filament lamps which has been announced and described by Mr. John W. Howell before this Institute[2] has resulted in the commercial production of lamps which operate on a 2.5-watts-per-candle basis instead of a 3.1-watts-per-candle basis.

A German firm, going back to the class of materials employed in the earliest attempt at the manufacture of incandescent electric lamps, has produced a lamp with a wire of tantalum as the glowing body and with an efficiency greatly in advance of that of the established carbon filament. More recently still, various experimenters have succeeded in producing lamps with a filament of metallic tungsten which carry the standard of efficiency to a point far beyond that obtainable with either carbon or tantalum. Since the graphitized or "metallized" carbon filament has in this country become a regular commercial product, the properties of which are moderately well known, it is deemed best in this paper to take up more in detail the peculiarities or the properties of the tantalum and the tungsten lamps.

It is not necessary in this place to go into a discussion of the processes of manufacture of the filaments of the metallized carbon and of the tantalum lamp, nor of the appearance of the lamps themselves, since these have become quite well known. In the case of the tungsten lamp, certain peculiarities of the construction are made necessary by the properties of the tungsten filament itself. The metal tungsten (German "wolfram"), while ordinarily reckoned as one of the rare elements, yet is, from the point of view of lamp manufacture, quite plentiful enough for all practical purposes. While its price per pound is high, yet considering the weight of the metal entering into an incandescent lamp, it is not especially expensive. The metal is infusible by any ordinary process. The melting point of tungsten filaments has recently been given by Waidner and Burgess[1] at 3,200° cent. The metal is commercially obtainable in the form of a fine powder. Tungsten does not seem to be ductile, so it is impossible to draw it directly into a fine wire. It unites readily with oxygen and with carbon at high temperatures. These peculiarities have made the problem of the production of

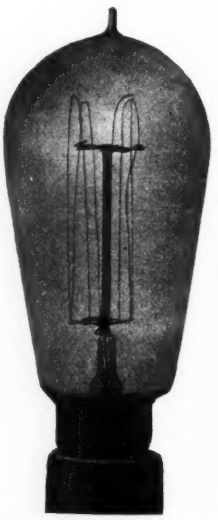


FIG. 1.—110-VOLT OSRAM LAMP.

tungsten filaments a rather difficult one. It has been attacked from several sides, and different processes for the manufacture of tungsten filaments have resulted therefrom.

The earliest process to be brought to public attention was that of Dr. Kuzel. Kuzel's process consists in the production of a colloidal solution of tungsten by forming an arc between terminals of the metal under the surface of water. The colloidal solution, when it has been brought to the proper consistency, is squirted through a die into filaments, which after being dried are converted to the crystalline condition by the passage of an electric current through them. In this way the filament is produced without introducing any carbon, which would unite with the tungsten to form tungsten carbide, a compound which is readily formed and which is very detrimental to the quality of tungsten filaments.

Another process is the substitution process of Dr. Just and Hanaman. This process seems to be very similar to one patented by Lodyguine some ten years ago. In this process a very fine carbon filament is heated in an atmosphere of a chloride of tungsten and hydrogen. Under proper conditions of the experiment, tungsten is deposited upon the carbon filament, the hydrogen acting as a reducing agent. By heating the filaments by means of a current the whole filament is converted into tungsten carbide. The carbon made is then removed from the filament by heating the same in an atmosphere of steam and hydrogen. The steam is decomposed, its oxygen uniting chiefly with the carbon of the carbide. Whatever tungsten is oxidized in this process is reduced again by the hydrogen which is present. It is impossible to say exactly whether this process is actually used in the manufacture of these lamps or not, though the statement may be made with a reasonable degree of certainty that some substitution process is used by Dr. Just and Hanaman.

The manufacture of filaments of osmium presented a problem similar to that of the tungsten filament. It is, therefore, natural that the process of Dr. Auer von Welsbach should by proper modification be adapted to the manufacture of tungsten lamps. Experiments along this line have been carried on by the companies in Germany and Austria which have been engaged in producing osmium lamps. To the tungsten lamp manufactured by the Osmium Lamp Company of Vienna has been given the name of the Osmin lamp. The tungsten lamp of the Auer Company of Berlin is called the Osram lamp. While it is reasonably certain that the details of the processes of manufacture of these two lamps differ from each other, yet they are probably alike in their general features. The method consists in forming a paste of finely divided tungsten with a binder of organic material such as, for instance, sugar solution, and squirting the same into filaments through a die. The carbon is then removed from the filaments by heating the latter in an atmosphere of steam and hydrogen or by the use of some similar process.

Still another tungsten lamp is known as the "Z" lamp. The process by which it is manufactured involves also a squirting of a paste consisting of finely divided tungsten with an organic binder, but differs from the other in the method employed to remove the carbon.

Tungsten lamp filaments manifest all

[1] A paper presented at the 211th meeting of the American Institute of Electrical Engineers, New York, November 23, 1906. Slightly condensed.
[2] Asheville convention paper, 1905.

[1] *Electrical World*, 1906, vol. xlviii, p. 915.

the ordinary properties of wires of pure metals. They have high conductivity and a large positive temperature coefficient. The high conductivity of the material requires that the filaments shall be very fine and quite long if they are to be used in producing lamps giving a reasonably low candle-power on 110-volt circuits. The degree of fineness to which it has been possible to reduce these filaments is indicated by the following table:

	Diameter.
Tantalum, 110 volt, 22 c-p	0.052 mm.
Osmium, 16 volt	0.103 "
Z New	0.1 "
Z After burning	0.055 "
Osram, after burning	0.044 "

A fine hair may have a diameter of about 0.06 mm. In view of the extraordinary degree of fineness which has already been attained in the manufacture of these filaments it does not seem probable that very much more can be looked for in this direction.

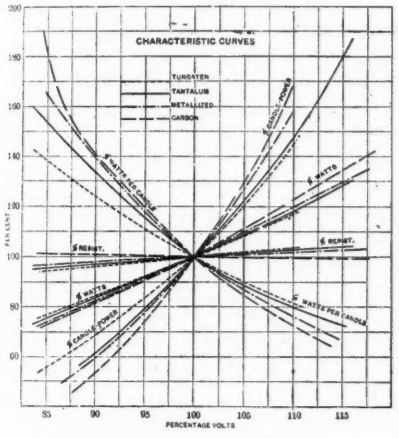


FIG. 2.—CHARACTERISTIC CURVES.

Tungsten filaments, when at the temperature of full incandescence, are quite soft. It is, therefore, not feasible to produce them and mount them in lamps in any other form than in loops. The result is that the tungsten lamp takes on the appearance shown in Fig. 1, which illustrates a 110-volt Osram lamp. In this lamp it will be seen that the filament consists of four loops. The ends of each loop are attached by means of a paste or by actually fusing them fast by the use of an electric arc to wires brought out from the stem of the lamp. The stem of the lamp is prolonged and carries at its lower extremity wires which serve as guides and supports for the loops of the filament. All the lamps which have been exhibited up to the present time have been intended for burning only in a pendant position. It can be stated, however, that by certain modifications in the details of construction lamps are now being made which can be burned in any position. The first tungsten lamps produced were designed for low voltages. In consideration of the high conductivity of the material, the production of a low-voltage lamp is a more simple problem than the production of one of higher voltage, since for low voltages a shorter length of the filament may be employed. It would seem also that it is easier to produce a lamp of high candle-power than of low candle-power, since a stouter filament may be employed in the high candle-power lamp.

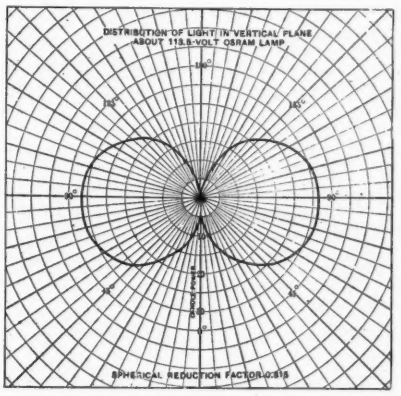


FIG. 3.—DISTRIBUTION OF LIGHT IN A VERTICAL PLANE ABOUT 113.5-VOLT OSRAM LAMP.

As far as the writer knows, no 110-volt lamps have been produced as yet for lower candle-powers than 25 and no lamps have been produced for higher voltages than 220. The fineness of the 110-volt, 125 candle-power filament is such that it would seem to be difficult to produce such a lamp as a regular commercial article. The 220-volt lamps are probably only experimental as yet. The properties of the tungsten filament are such that it would seem to lend itself very readily to the production of most excellent lamps for street lighting by the series incandescent system. Lamps for 110 volts are likely to have when commercially produced a watt consumption of 50 watts or more. If tungsten lamps are to be made for small candle-powers, such as are commonly employed in domestic lighting, they would probably need to be made for fifty volts or under, and consequently either burned in series or connected to low-voltage mains.

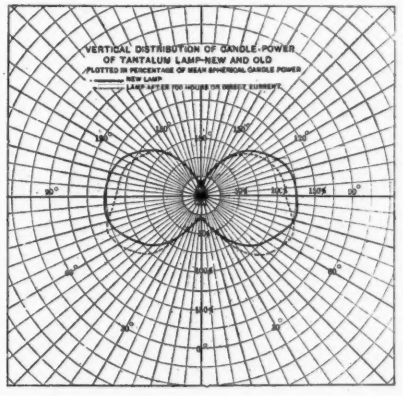

VERTICAL DISTRIBUTION OF CANDLE-POWER
OF TANTALUM LAMP—NEW AND OLD
PLOTTED IN PERCENTAGE OF MEAN SPHERICAL CANDLE POWER
NEW LAMP
LAMP AFTER 700 HOURS ON DIRECT CURRENT

FIG. 4.—VERTICAL DISTRIBUTION OF CANDLE-POWER OF TANTALUM LAMP—NEW AND OLD.

One of the chief disadvantages of the tungsten lamp lies in the extreme fragility of its filament. Blows or shocks given to the lamp are quite likely to cause a rupture of the filament. A ruptured filament may, however, mend itself by the parts welding together once more, but where the filament has become welded it is quite likely to break loose again.

The tungsten and tantalum filaments have positive coefficients which are, moreover, much larger than the positive coefficient of the "metallized" carbon. The temperature coefficients of tantalum, osmium, and tungsten filaments have been determined by measuring the resistance of these filaments at room temperature and again at 100 degrees centigrade. They were as follows:

Tantalum	0.234 per cent per degree.
Osmium	0.372 " " " "
Tungsten (Osram lamp)	0.438 " " " "

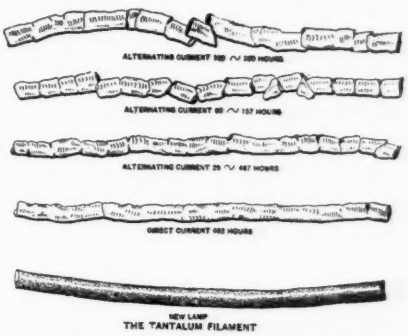


FIG. 5.—TANTALUM FILAMENT UNDER VARIOUS CONDITIONS.

The effect of the positive coefficient is to give the metal-filament lamps considerable inherent regulation. That is, the change of current through the lamp is no longer proportional to the change in voltage, but is smaller proportionally than the change in voltage. Consequently in watts, candle-power, and watts per candle, these lamps undergo smaller changes with the change in the line voltage than in the case of the carbon-filament lamp. These characteristics are brought out in the curves of Fig. 2.

The distribution of luminous intensity in the horizontal plane for both tantalum and tungsten lamps must be on the average a circle, due to the method of construction of the lamps. This circle contains in each case a number of narrow maxima which are due to reflections from

the opposite side of the bulb. Curves of vertical distribution of a tungsten lamp and of a new and an old tantalum lamp are shown in Figs. 3 and 4. The difference between the curves of the old tantalum lamp and the new tantalum lamp brings out a marked peculiarity of the tantalum lamp when constructed with a straight-sided bulb. It points to a change in the spherical reduction factor or ratio of the mean spherical to the mean horizontal candle-power of the lamp during its life. Such a change is actually shown by the lamp. The change in vertical distribution may be traced to two causes: first, to the deposit of black material left on the bulb in a zone of a width substantially the same as the length of the spires of filament stretched between their support, and to an increased roughness of the filament.

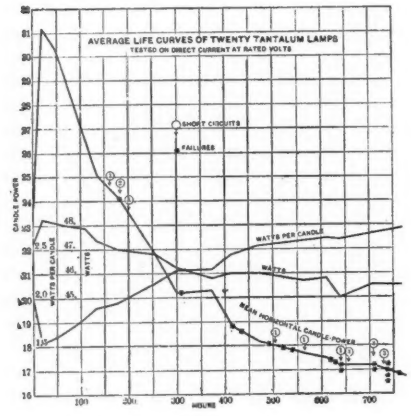


FIG. 6.—AVERAGE LIFE CURVES OF TWENTY TANTALUM LAMPS.

It has been customary to consider as the useful life of a carbon-filament lamp its life up to the time when its candle-power has fallen to eighty per cent of its initial value. Beyond this point it has been considered cheaper to discard the old lamp and replace it with a new one; in other words, this has been taken to be the proper "smashing point" of the lamp. It should be pointed out that this relation does not hold with the metallic-filament lamps. The smashing point of a lamp is determined by considerations of initial cost of the lamp, the cost of electrical energy, and the rate of decline of the candle-power of the lamp. In the metallic-filament lamps we have lamps of much higher economy, not only initially, but throughout their life; they are lamps of higher candle-power and necessarily of higher initial cost. It would seem that the data at present available regarding such lamps are not sufficient to permit of the proper determination of the smashing point. Certain it is, however, that where such lamps are used they are likely to be burned until they fail.

Some of the earliest tests of tantalum lamps made in this country showed a much poorer behavior than was claimed for the lamp by its makers. In these tests the lamps were burned on alternating-current circuits. Since there was no reason to suspect that the lamps were suffering on account of incorrect voltage or rough handling, the conclusion was almost inevitable that the nature of the current might be influencing their life. On trial it was found that tests made on direct current instead of alternating gave results which were in general agreement with those which had been published abroad. Since that time the effect of alternating current in shortening the life of a tantalum lamp has become well recognized.

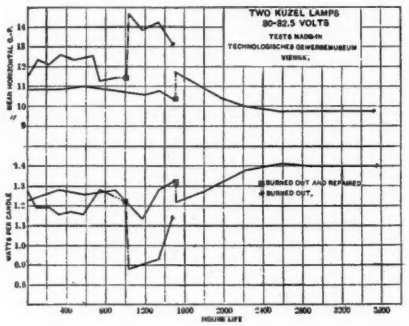


FIG. 7.—TESTS OF TWO KUZEL LAMPS.

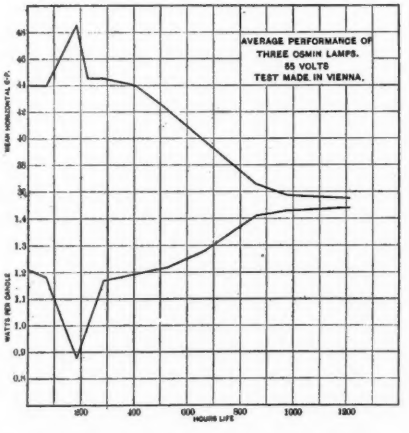


FIG. 8.—AVERAGE PERFORMANCE OF THREE OSMIN LAMPS.

A microscopic examination of the tantalum filaments, new and burned on direct current and alternating current of different frequencies, is extremely interesting. A free-hand drawing of such filaments as seen under the microscope is given in Fig. 5. It will be seen in this figure that the unused filament is smooth and polished with only slight pittings on the surface. The filament which has been burned on direct current is much less regular; its surface shows deeper pittings and, in places, it is cut and notched as if with a knife blade. Some parts of the filament are much more irregular than others. The filament on twenty-five cycles shows still stronger markings of the same character as shown on the direct current, but shows also, in places, a jointed structure looking like the jointed structure observable sometimes in basaltic rocks. This latter effect is even more marked in the case of the filament which has been run on sixty cycles. Here, parts of the filament look as if they were made up of blocks which had been irregularly piled one on the other. The length of these jointed sections in the filament is about equal to the diameter of the filament itself. It looks, in some places, as if one of these sections had been almost expelled from the row. The appearance, too, is very much as if where these joints occur, the filament had actually separated and had welded itself together instantly. The filament which had been operated on 130 cycles had the same appearance, perhaps somewhat exaggerated. In short, the increased wear and tear of the filament, due to the use of the alternating current, is very apparent. The reason for it, however, is obscure. The conclusion is inevitable that this lamp at the present time is essentially a direct-current lamp.

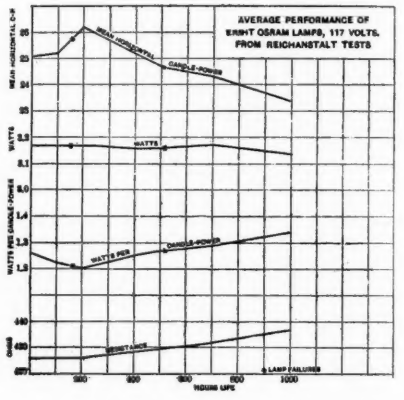


FIG. 9.—AVERAGE PERFORMANCE OF EIGHT OSRAM LAMPS.

No such effect is observable with the tungsten lamps. Tests of the Electrical Testing Laboratories show quite definitely that their life on direct current and alter-

nating current is the same. This has also been proved by elaborate experiments to be true of carbon filaments.

The average results of tests of twenty tantalum lamps of German manufacture on direct current are given in Fig. 6.

The life-history of tantalum lamps is characterized by a large initial increase in candle-power and a corresponding decrease in watts per candle, the extreme values being reached at the end of about

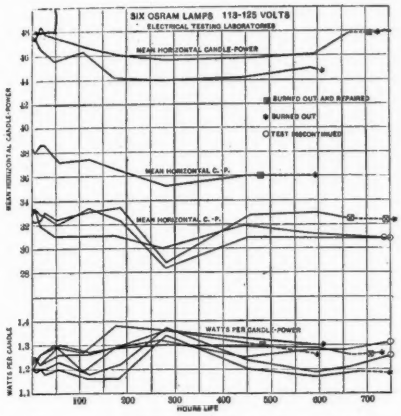


FIG. 10.—TESTS OF SIX OSRAM LAMPS.

twenty-five hours. From this point on, the candle-power decreases at a moderately rapid rate and the watts per candle increase. The result of the relatively slow decrease of mean spherical candle-power with a large initial increase, is that in some cases the final mean spherical candle-power of a lamp is actually greater

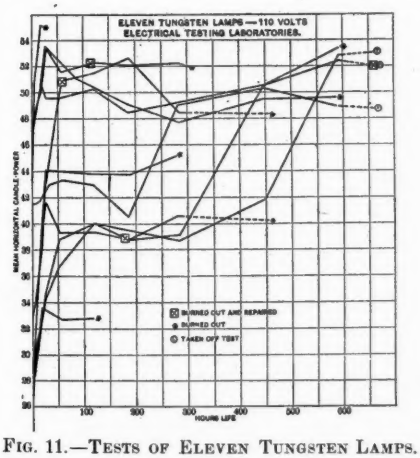


FIG. 11.—TESTS OF ELEVEN TUNGSTEN LAMPS.

than its initial mean spherical candle-power.

Results of tests of tungsten lamps made in various laboratories are given below. The data on some of the makes of tungsten lamps are extremely meagre; a circumstance which in some cases is believed to correspond to a backward state of their commercial development. Fig. 7 gives the results of tests[1] of two Kuzel lamps of approximately 30 volts and 11.5 candle-power, made at the Technologisches Gewerbe-Museum in Vienna. These lamps consumed approximately 1.25 watts per candle initially. One of them reached the extraordinary life of 3,537 hours, with a decrease in candle-power of about ten per cent. The filaments in both the lamps were burnt through and repaired once in the course of their life. The result of the repair was an increased candle-power, which is shown clearly on the curve.

The average result of tests of three Osmin lamps of fifty-five volts and forty-four candle-power are shown in Fig. 8. These tests were made in the laboratory of an electrical company in Vienna. The lamps showed a life of 1,200 hours and a decrease in candle-power of fourteen per cent in that time. The results of a test of three Osmin lamps of fifty-five volts made at the Municipal Electricity Works, Vienna, showed an initial candle-power of 27.3 and initial watts of candle-power of 1.25. After 2,239 hours of burning the candle-power was 23.4 and the watts per candle 1.45. Six fifty-four-volt Osmin lamps tested at the Technologisches Gewerbe-Museum consumed initially 1.17 watts per candle. After 1,776 hours the watts per candle were 1.24. The candle-power of these lamps is not given in the report. It should be noticed that all the above lamps are low-voltage lamps, from which a better result is to be expected than from 110-volt lamps.

Fig. 9 shows average values of candle-power, watts, and watts per candle of eight 117-volt lamps from among those given in the above tests.

In Fig. 10 are shown the individual curves of six Osram lamps of thirty-two, thirty-five, and forty-five candle-power, tested at the Electrical Testing Laboratories. The results of these tests differ from the results of the Reichsanstalt test in that they show practically no initial rise in candle-power. The decrease in candle-power of the lamps throughout life, however, is very slow. The watts per candle are also almost constant. The life of the lamps was on the average considerably shorter than the life of those tested at the Reichsanstalt.

Candle-power curves of eleven tungsten lamps of quite another foreign make as tested at the Electrical Testing Laboratories are shown in Fig. 11. These lamps exhibit a very large initial increase in candle-power, followed by a practically constant condition. The average life is also much shorter than in the case of the Osram lamp.

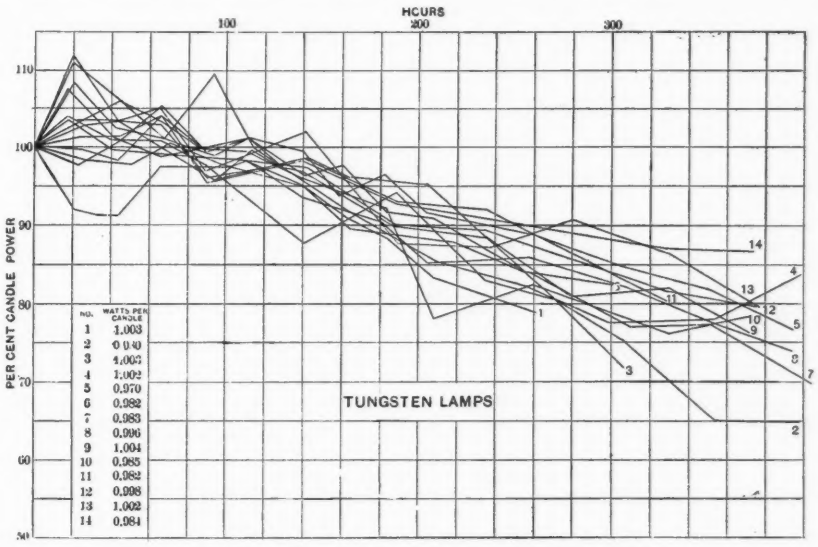


FIG. 12.—LIFE-EFFICIENCY CURVES OF TUNGSTEN LAMPS.

The curves of Fig. 12 are of particular interest since they show the performance of lamps made in this country. These lamps were tested at an average initial consumption of 0.99 watt per candle. Their average life was 363 hours even at this high initial efficiency, and the average decrease in candle-power was 17.7 per cent. These curves demonstrate that incandescent lamps can be produced which will operate successfully at one watt per candle and will give a satisfactory life. The candle-power of these averaged about forty.

The color of the light from the tantalum lamp is whiter than that of the carbon

[1] Kremenezky "Elektrotechnik und Maschinenbau", 1906, No. 6.

lamp, and the color of the tungsten lamp is still whiter than that of the tantalum lamp. The light of the tungsten lamp resembles quite closely that of the acetylene flame. The increased whiteness of the light, which is produced evidently largely as a temperature effect and which does not involve a preponderance of certain colors, such as green or violet, constitutes a point of real superiority in the tungsten lamp. Time has been lacking to make a regular spectro-photometric study of these lamps. A simple experiment, however, has been made which gives some idea of the increased radiation of the shorter wave lengths, both of tungsten and tantalum lamps, as compared with the carbon lamp at 3.1 watts per candle.

The metal-filament lamps were photometered against the 3.1 carbon lamp directly and then with a red, green and blue glass interposed between the eye and the eye-piece of the photometer. The intensities so measured, expressed in percentages of the intensities measured without colored glasses, are given in the following table:

	Tantalum Lamp. Per Cent.	Tungsten Lamp. Per Cent.
Total light	100	100
Red light	90.5	83.0
Green light	100.3	101.8
Blue light	109.2	126.5

The increased whiteness of these lamps may theoretically be due either to higher temperature of the filament or to selective radiation by the filament. Recent work of Waidner and Burgess indicates that while the increase in the efficiency of tantalum and tungsten lamps, as compared with the carbon lamp, is to some extent due to the selective character of their radiating power, yet the chief cause of the increase is the higher temperature at which it is practicable to operate them. The higher temperature causes the maximum of the spectral energy curve to be shifted toward the shorter wave-lengths, and consequently a higher percentage of the total radiation is emitted in wave-lengths which are capable of exciting vision.

It has been established as a result of practice that in general it is not possible to operate incandescent lamps on 25-cycle current with satisfactory results. This statement is made with a knowledge of the fact that in certain cities a large amount of lighting is actually being done on twenty-five-cycle circuits. Yet under some circumstances twenty-five-cycle current produces such marked flickering of incandescent lamps that its use is absolutely impossible. It is an interesting question whether the tungsten lamp presents any advantages over the carbon lamp for use on low-frequency circuits. Its positive temperature coefficient and the relatively low radiating power of its surface would tend to reduce the flickering, while the extreme fineness of the filaments which results in a smaller thermal capacity and the high thermal conductivity which, as a metal it probably possesses, would tend to increase the flickering. A few preliminary tests have been made in an attempt to gain some information on this question. It was very quickly discovered, however, that the question is so very complicated that a considerable research will be required to ascertain definitely the facts of the case. Eleven tungsten lamps were attached to the ceiling of a small room, producing a brilliant illumination in the room. Three observers attempted to determine the presence or absence of flickering. With the lamps at their normal voltage of 115 and with a frequency of 25.5 cycles per second, L. found the flickering marked; M. found the flickering marked; S. could see a flickering intermittently, as when his head was moved suddenly. With the same lamps, but with the voltage reduced to 100, the flickering was imperceptible to all the observers.

As the voltage was raised successively to 105 and 110 volts the flickering became perceptible. When five of the lamps were removed, leaving only six lamps in position, it was the consensus of opinion of the three observers that the flickering was less marked than when all the lamps were in. In other words, the intensity of the sensation of flickering seems to be a function of the illumination. The flickering was imperceptible when looking directly at the lamps, but could be observed only through light which is not focused directly on the fovea of the eye. To institute a comparison between the flickering of the tungsten lamps and of carbon-filament lamps a sufficient number of carbon-filament lamps of candle-power comparable to the candle-power of the tungsten lamps, lamp for lamp may be taken. That is to say, twelve thirty-two-candle-power carbon lamps were substituted for the eleven tungsten lamps. These were operated at 3.1 watts per candle. At the same frequency as was used for the tungsten lamps, no flickering could be observed. This is not a surprising result, since the diameter of carbon filaments is much greater than the diameter of the tungsten filaments, and consequently their thermal sluggishness is a much more important factor.

In view of the very considerable advantages which would be gained if it could be shown that it is feasible to operate incandescent lamps on alternating-current circuits of frequency low enough to permit of the easy operation of synchronous converters, that is to say, a frequency of twenty-five cycles or slightly greater, the question of the variation of the light of incandescent lamps during a half cycle of the alternating current has also been subjected to an experimental investigation by the use of a stroboscope. The curves so obtained, while exhibiting certain irregularities due to experimental difficulties, are fairly concordant and exhibit to a common character. The percentage variation seems from these curves to be expressible by two linear relations, with a point of sharp curvature occurring between twenty-five and thirty cycles per second. That is, as the frequency is increased from fifteen to twenty-five cycles the diminution in flicker is very rapid. Above thirty cycles the diminution in flicker is very slow. Since it has been found possible in some places to operate incandescent lamps on twenty-five cycles, it would seem probable that a comparatively small increase in the frequency, which would carry the lamps beyond this apparently critical point in the curve, might make feasible the general operation of incandescent lamps from alternating-current power circuits.

Similar tests to the above have been carried out on a forty-watt, thirty-five-candle-power, 115-volt Osram lamp. The results of this test indicate that the stroboscopic variations of a tungsten lamp of this size are not much different from those of an ordinary lamp rated as on eight-candle-power lamp when forced to 2.5 watts per candle. The stroboscopic measurements, however, may be subject to certain ones of the difficulties which affect the detection of flicker by the eye. In other words, the degree of intensity of the light upon the photometer disc may have an influence on the results obtained. However, if the results of this preliminary test, which has been made in a very limited time for the purposes of this paper, can be confirmed by later and more careful experiments, the tungsten lamp will be found to be less adapted to use on alternating circuits of low frequency than the standard lamp of to-day.

From the data given above it seems certain that the electric lighting industry is face to face with a change of almost revolutionary character. The standard of incandescent lighting efficiency will be brought by the tungsten lamp to a point about three times as high as it is at present. The efficiencies of all other incandescent lamps and of enclosed arc lamps are exceeded by that of the tungsten lamp. In other words, with the possible exception of some forms of vacuum-tube lighting and of the magnetite and flaming arc lamps, the tungsten lamp is the most efficient electric illuminant. Combined with its virtue of high efficiency it has the other advantages of incandescent lamps in being perfectly simple in its character and construction and in being capable of subdivision into small units.

"Seeing Electrically."

TO THE EDITOR OF THE ELECTRICAL REVIEW:

The interesting communication on "Seeing Electrically," from A. W. Storm, which was published in your issue of November 17, goes to show that there are a good many men at the present studying this problem. It is too bad that he did not in that article give us some inkling of the ideas that he has been storing away for these many years of his study of the subject. Equally unfortunate is it that the two men mentioned as having solved the problem, have also seen fit to withhold the details of their methods. It is much to be hoped that there is good foundation for their claims, and I shall watch eagerly for the descriptions of their apparatus.

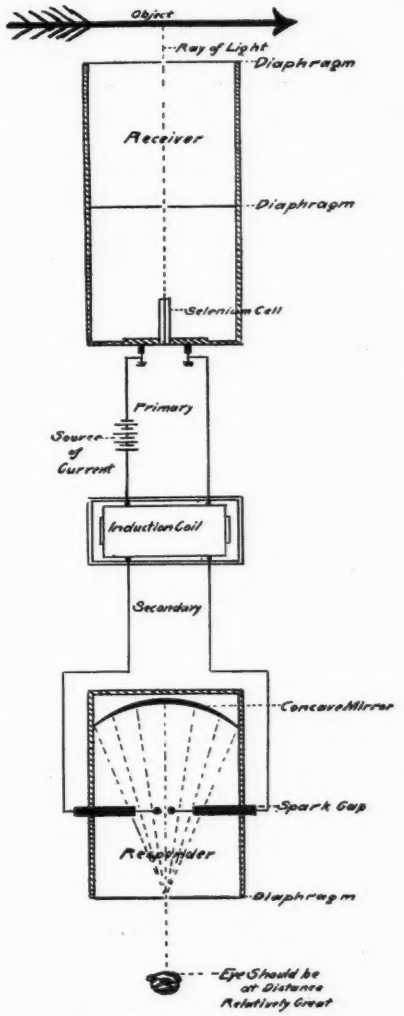
If all those engaged in the study of this intricate and difficult problem could pool their ideas we might have an actual working, though perhaps crude "optigraph" much sooner than most of us think. Why not let each one who has any idea bearing on this matter publish it, and thus help to an early solution of this most interesting problem? In accord with these views, may I submit what has seemed to me a possible solution? Having carried out as yet no experiments, the plan, of course, is purely theoretical.

In the first place, the plan is to do away with the necessity of throwing the shadow of a negative upon a selenium screen and instead to look, as it were, upon the object itself, any changes or motions in the object to be recorded as faithfully as those parts which remain motionless.

A sensitive selenium cell is made by clamping together two strips of copper between which is placed a very thin slice of mica only a few thousandths of an inch in thickness; after clamping the ends are dressed off to give a smooth surface for the delicate coating of selenium, which is crystallized, so as to be most sensitive to light.

This cell is placed in the bottom end of a hard-rubber or other suitable tube an inch or less in diameter, and perhaps three inches long. The sensitive end of the cell is located in the centre of the tube and pointing toward the open end. Midway of the tube a diaphragm of some very thin opaque material is placed and near or at the open end another like it is located. A pinhole is drilled in the exact centre of each of these partitions in such a way that a ray of light passing through both pinholes strikes the selenium cell exactly in the centre between the copper plates or at a point exactly over the edge of the mica. In this way light from but a small point at a time can be reflected into the tube and strike the sensitive cell.

The tube is so mounted on a movable mechanism that it will be made to pass over or in front of a small square of perhaps three or four inches to the side.



ARRANGEMENT OF APPARATUS.

It must move so rapidly as to pass before every portion of this square within the space of one-tenth of a second, which is the recognized time for the persistency of vision, and must repeat it over and over at the same speed.

The object to be seen can not exceed in size the square over which the tube moves, and must be placed directly in front and within the limits of the square. Having a good light thrown upon the object, it will be evident that a ray of reflected light will be cast upon the selenium cell from every point of the object in its turn, but light can enter but from a single point at one time. This causes the cell to be more or less conductive, according to the particular shade of the point on the object before which it happens to be at any instant. The inside of the tube, of course, should be blackened to prevent reflections.

A current of electricity is caused to flow in a circuit which includes the selenium cell, the current varying with the fluctuations of the resistance of the cell. The wires of this circuit pass to a reproducing station and cause fluctuations in a light. To successfully reproduce the image being transmitted would seem to be a particularly difficult task, from the fact that the amount of light represented by the varying current in the circuit must change so rapidly from maximum to minimum that there is no known source of light capable of following it without considerable lag, which, of course, means failure.

The possible exception may be the induction-coil spark, which is free from solid filaments and substances to be heated and cooled.

The induction coil may be capable of being interrupted sufficiently fast to produce sparks of varying brightness to obtain the desired results. On this supposition let us proceed. At the reproducing end of our circuit a tube similar to the one already described, only somewhat shorter and possessing but one diaphragm, is mounted on a moving mechanism exactly like the one already described.

In the bottom or back end of the tube is mounted a concave mirror of such focus as to reflect all rays to a small pinhole in the diaphragm of the tube, located in this case at the outer end.

Between the reflector and the diaphragm is a spark-gap, so located as to give the best results with the reflector and condensing all the light possible at the pinhole of the diaphragm. The wires from the selenium cell are brought as primaries to an induction coil, the secondaries of which connect to the opposite sides of the spark-gap in the tube. The tube-carrying mechanisms are driven synchronously, so that they are always in the same position with relation to the squares they are each describing or covering.

As the current varies with the action of the selenium, the brightness of the spark in the reproducing tube is increased or diminished accordingly, thus making the pinhole as seen from directly in front grow bright or dark as the case may be. This point of varying light exactly repeating itself over the same space once every tenth of a second produces a view of the object at the receiving end which persists as long as the apparatus is kept in motion, and should changes or motions take place in the object, they will also be seen.

W. L. CHAMBERLAIN.

West Hartford, Ct., November 22.

WHAT IS AN ENGINEER-CONSTRUCTOR?[1]

BY GEORGE A. DAMON.

One prominent element of modern industrial life is bigness. We have large business corporations, combined railway systems, extensive manufacturing concerns and comprehensive enterprises in all lines of commercial activity.

Another dominant element is efficiency, which may be taken as the key word of modern business life and engineering practice. The constant aim is not cheapness in construction or equipment, but effectiveness, the greatest return for the outlay.

These two elements chiefly have brought about a condition in which we have the necessity for a technical organization ready to produce large results in an effective way. Between the desire for bigness and efficiency and its fulfillment is the field of operation for the creative and constructive abilities of the "engineer-constructor."

An "engineer-constructor" is an organization, and not an individual. It makes possible the most effective combination of technical theory with practical experience, and provides for the use of "team work" in connection with the designing and building of properties. Its aim is to attain the greatest economy in effort, time and money—its province is to "do" things in the most effective way.

In its broadest development such an organization need not be confined to any one class of enterprise. Here is something to be built which requires for its completion a combination of conception, technical knowledge, construction experience and executive ability. Whatever it is, the "engineer-constructor" should be prepared to carry the proposition through from beginning to end without technical assistance from outside the organization. To be most effective, such an organization should have at its command the technical knowledge and experience of the past; the ability to analyze situations, and discover the truth from conflicting testimony; the imagination to conceive unprecedented results and courage to overcome obstacles; the ambition to improve existing systems, and the honesty to spend money without favor or graft; and finally loyalty to itself and to its client, which will protect in every way the interests of all concerned.

An "engineer-constructor," therefore, is nothing less than an ideal employé who has the best possible preparation, the widest experience and the natural aptitude to do in a large way the big things which the development of this country is constantly requiring. Such an organization substitutes for the isolated efforts of one or more individuals an effective combination of the aggregate abilities of a number of experts and adds the enthusiasm and inspiration which come from the contact of fellow workers.

It is an organization in which men of various training in engineering and industrial work of all kinds are fitted together as a mechanic would build a machine, and the efficiency of such an organization for the purpose for which it is created depends upon, first, the perfection of its individual parts; second, upon the skill with which these parts have been brought together; and, third, upon the absence of any unnecessary friction during operation.

Such an organization should not be the maker or manufacturer of any equipment, nor be connected with the exploitation of any system of apparatus, nor interested in the introduction of any patented devices. In its highest stage of development it will not be connected except in a technical way with the financial interests which control the enterprise.

To show the possibilities of such an organization, let us pick out a staff for the design and construction of a steam railroad locomotive repair shop, involving the expenditure of from two to three million dollars. The selection of men with their chief duties will be as follows:

Industrial Expert	Designing Layout of Shops. Planning Method of Handling Work. Arrangement of Tool and Transportation Equipment.
Electrical Engineer	Providing Power and Lighting Equipment. Laying Out Transmission Systems. Planning Telephone and Signal Systems.
Mechanical Engineer	Design of Power Plant. Plan of Heating and Ventilating. Laying Out Air, Gas and Steam Systems.
Structural Engineer	Building Foundations. Designing Steel Structures. In Charge of Reenforced Concrete Construction.
Architect	Designing Building Superstructure. Choice of Fixtures. Laying Out Landscape Work.
Civil Engineer	Directing Grading. Testing of Soil. Construction of Track.
Sanitary Engineer	Design of Sewage System. Construction of Water Works. Choice of Plumbing.
Purchasing Agent	Selecting Markets for Material. Checking Bills of Material. Arranging for Delivery of Material.
Constructing Superintendent	Organization of Construction Force. Consideration of Time Element in Construction. Settling Labor Difficulties Arising in Connection with Construction Work.
Operating Engineer	Consideration of Economics in Operation. Securing Reliability in Operation. Insuring Effectiveness in Operation.
Accounting Department	Keeping Pay Rolls. Making Record of Costs. Preparing Progress Reports.

The first work will be a number of preliminary studies, showing the proposed sizes, designs and relative arrangements of the buildings. There will next be forthcoming a carefully prepared report, showing the advantage of the finally selected arrangement, and the suggested construction of each of the buildings, together with a description of the equipment required. An important part of this preliminary report is an approximate estimate of cost, based upon a careful consideration of all the items involved in the construction.

With the general layout and the preliminary report and estimate approved, the next move is to prepare the plans and specifications.

The plans should preferably be drawn upon one size of paper and every drawing should be numbered to correspond to the

[1] A paper presented to the Electrical Section, Western Society of Engineers, November 16, 1906.

classification. A border and a standard title printed by a draughting-room outfit gives a finished appearance to each drawing.

Specifications can now be printed very quickly, and when at least twenty copies are required, they can be produced in this way as cheaply as by carbon copies, or the better method of blue-printing from a typewritten record.

In purchasing, the "engineer-constructor" should find some advantage over an occasional buyer. He is in the market constantly, is favorably known by the manufacturers of standard equipment, and buys apparatus delivered f.o.b. cars, doing all erection work as far as possible with his own experts, and calling on the factory for assistance only when necessary.

Throughout the entire progress of the work, systems are in use to keep all concerned informed as to each move. The construction office is advised by the home office as to the material ordered and as to the probable delivery of this material. The home office is advised as to the receipt of material on the job, as well as to the progress of the construction work, and any reports and advices as to the labor situation. To accomplish the former copies of contracts for apparatus and orders for material are sent to the superintendent in charge of construction. Such reports and orders contain exact information as to the material covered by them, as well as to the time at which this material is expected to arrive on the work. A card system in which are entered all orders and contracts is used in the home office, and is designed to follow up and secure prompt delivery of all material and apparatus. In case of any changes in time of delivery of material, the construction superintendent is advised in advance, and is thus in position to make any alterations necessary in his program. The importance of promptly delivering the material on the job can not be overestimated, and the value of a system that will provide for the delivery of the materials in accordance with an approximate schedule previously arranged for will appeal to all interested in construction work.

Practically all of the material is ordered by the home office. In case, however, it is more advantageous to order small quantities at the seat of the work, such orders are issued by the superintendent, a copy of all such orders being sent to the home office, after which they are recorded and handled in all respects similar to orders issued from the office.

Records of all material received on the job are kept by the superintendent in the form of a material report. These reports are written out in a duplicate book as each shipment is received, and one copy is sent without delay to the main office. This serves to keep the home office very closely in touch with the field work, so far as the receipt of material is concerned.

In construction work consisting of a great many items, such as will be found in railroad shops, it is very desirable to know with a fair degree of accuracy the exact progress of the work. Certain lines of the work, such as the delivery and installation of machinery, are dependent upon the progress of other work, such as the completion of the buildings and foundations. In order that this information may be always at hand, progress reports from the work are received at stated intervals, usually two weeks apart, giving in detail the progress of the work under each classification head. This information is kept in form for convenient reference, and is useful in a variety of ways. Not only do these reports keep the engineering force in touch with the progress of the work, making it possible to more efficiently insure the work coming in proper sequence, but they also provide the information necessary to make decisions as to changes in detail, in case such are found necessary after the work has been begun. These progress reports, together with a record of moneys expended for material and labor at any date, give timely information as to the actual cost of the work as compared to the estimated cost. As such reports are made on the work under each classification heading, any variation of the cost from the estimate is at once detected. This is of importance to the constructor who proposes to complete a certain improvement within a definite estimated cost, and to the client's official who may be charged with the responsibility of protecting a definite appropriation.

Wherever it is possible, curves or diagrams are used to represent the condition of affairs of which record is to be kept. A chart showing the progress of the work on building construction is easily made, and shows very clearly at a glance the exact condition of the work at any time.

Although every facility is provided for keeping the main office and the construction office in close touch, it should not be understood that the engineering is done at arm's length, and that all plans and specifications are devised and completed by an engineering force in the office to be sent down to the construction superintendent on the job for his execution. A competent engineer is in charge of all construction work, and spends a certain amount of time in the field, thus putting him in close touch with the situation, and enabling him to more efficiently direct the detailed engineering work that is done in the main office.

It would be a big mistake to think that such an organization as we are outlining could be got together and perfected in its work in a short time. It will probably take years, and it is evidently for this reason that this very inviting field is occupied by so few organizations who are really prepared to do the work justice.

Ten years ago the president of the Arnold Company was a consulting electrical engineer—an expert on electrical questions, and in a consulting capacity only. Then came the natural addition of mechanical problems—still in a consulting capacity. The introduction of the system of rotary converters for electric railway work, and of an improved system of power plant construction, made it necessary to take two contracts in which the results of these two systems, which were advised by the consulting engineer, were guaranteed. Thus a contracting company was formed and a construction department organized. This move developed the fact that the same brains which made the plans for an installation could be mixed with some enterprise and business ability, and thus actually bring about a complete result.

This worked so well that other contracts for complete electric systems were sought and secured—sometimes as engineers, sometimes as constructors, occasionally as both. Civil, structural, architectural, industrial and hydroelectric departments were added as the business grew. Systems of carrying on the work were perfected as experience dictated, and weak parts were made stronger. To-day this company has on its payrolls a technical force of over eighty men, and often employs on its construction enterprises thousands of skilled mechanics, experienced foremen, and unskilled laborers.

Most of the work of this company is done on the basis of "cost plus a percentage," that is, the work is done at actual cost, and then the "engineer-constructor" gets a percentage fee for his services. By such an arrangement the client or purchaser is relieved of the necessity of organizing a technical force of his own, or of employing a number of individual specialists. If the actual construction work is turned over to the "engineer-constructor," then the client is relieved of the inconvenience of obtaining proposals and awarding contracts to a large number of separate contractors, with the attendant delays, conflicts and "extras," which even the closest supervision will hardly avoid.

Electrical Notes from Great Britain.

(From Our British Correspondent.)

SO FAR as London is concerned the electrical topic of the hour is that of power supply. This revival of interest in the subject is due to the publication of the new proposal of the London County Council, which has been drawn up at the suggestion of its Highways Committee with the combined assistance of such experts as H. F. Parshall, Robert Hammond, J. F. C. Snell, Mr. Fell, the council's tramway engineer and manager, and J. H. Rider, the tramway's electrical engineer. Briefly stated the scheme is: To purchase five years hence the electricity supply undertakings of fourteen municipal corporatic (in London) which have cost close upon $30,000,000, reserving the right to control capital expenditure until the purchase takes effect; to make agreements with many similar authorities outside London either for purchase or with provisions that they may continue to act as local distributors; to provide for buying the London companies (which have spent about $65,000,000) at the time they become purchasable by existing municipal corporations (roughly speaking, the year 1931), or earlier in particular cases by special agreement; the erection of a big generating station at Barking or Erith to cost $7,000,000 or more, including land, with an additional outlay of some $13,000,000 for the transmission and distribution system. Railways, tramways and other large consumers are reckoned among the prospective purchasers of current. The first two sections of the station would be completed by 1910. The total area which the council wants to supply, or to control the supply of, is 451 square miles, but only 117 square miles are in London. The remaining 334 are in the surrounding districts in Essex, Kent, Surrey and Middlesex. The scheme has been met with storms of criticism and opposition in many quarters, chiefly on financial grounds, and those who are against London's piling up municipal indebtedness are getting their plans into shape for throwing out the reckless "progressive party" which is responsible for the proposal, at the public elections next March. That would be a death-blow to the scheme, but it would still leave open the way for a new undertaking as originally fought for by C. H. Merz, or for combined action on the part of the existing supply companies. But it would be quite premature to discuss the subject further at this stage, for the air is full of proposals.

The new tube railway known as the Great Northern, Piccadilly & Brompton line, is practically finished. A trial run was recently made, and early in 1907 the system will be open for public traffic. This is a similar undertaking to the other tube lines of London. It runs between Finsbury Park in the north to Hammersmith, the length of the twin tunnels being seven and three-quarter miles. Energy is obtained from the great power-station at Lot's Road, Chelsea, from which the district and several other tubes are served. The 11,000-volt, three-phase current (33.3 periods), is reduced to a 600-volt, direct-current. The cars (Brush steel construction, externally finished in scarlet and white) measure forty-nine feet nine inches over platform, eight feet nine inches extreme width, and seven feet six inches from floor to roof. Each car has a seating capacity for fifty-four passengers, and weighs fifteen tons seventeen hundredweight, which represents a saving of twenty per cent when compared with the normal wooden railway coach. G. C. Cuningham, the general manager of the Central London tube line, designed these cars for the new line.

On November 13 C. F. Jenkin spoke on the subject of electric railway traction at the meeting of the Institution of Civil Engineers in London, and the discussion is to be continued at the next meeting. The single-phase system was the main theme, and naturally the author covered a good deal of the ground traversed in his paper read in the summer at the meeting of the British Association. Four years ago Mr. Jenkin, in conjunction with W. M. Mordey, read a paper before the Civil Engineers on railway electrification, and the present object was to bring that account of the different systems right up to date, showing how far the conclusions then expressed must be modified in the light of subsequent experience. A description of the single-phase system was given and some of the problems arising in connection with its working were discussed. Much historical and descriptive matter concerning the single-phase motor in its compensated series and compensated repulsion forms found a place in the paper, and it was contended that the conclusion of four years ago, that the single-phase was the only system to satisfy all the requirements of a general system, had been amply confirmed. The limits of voltage at which flickering is visible with glow lamps on a low periodicity supply were indicated in a table, and Mr. Jenkin also set out a method of calculation for finding the drop of voltage in any part of the circuit. Actual railway tests were shown to have confirmed such calculations.

So far the only actual example of single-phase traction in England is that at the Westinghouse works at Trafford Park. Equipment operations are, however, begun in connection with the South London line of the London, Brighton & South Coast Company, which will consist of about nine miles of double track, equipped on the Aktien Elektricitäts Gesellschaft system. For this there are to be some sixteen motor cars, each having four 115-horse-power motors. The pressure is 6,000 volts with a frequency of twenty-five.

The other English system for which the single-phase system has been actually adopted is the Heysham, Morecambe & Lancaster section of the Midland Railway, and part of the contract has been placed within the last month. There will be eight miles of double track, with 6,000 volts on the line and step-down transformers on the motor coaches. Energy will probably be obtained from the railway's existing gas-driven power station at Heysham. The rolling stock will at first comprise three motor coaches and four trailers. The Siemens & Halske Company has been ordered to supply one motor coach (and two trailers) equipped with two 180-horse-power compensated-series motors. The main transformer on the motor coach will deliver 320 volts to the motor terminals. The motors will be mounted on the bogie by centre of gravity suspension, the Midland Company suitably modifying the standard bogie. The motors are to be connected to the car axles through single-reduction gearing (ratio 40:18). Each track will have a single trolley wire with catenary suspension.

The condition of British electric manufacturing, so far as profit-earning is concerned, continues to be very unhealthy.

Foreign competition is less severe because other countries are more fully occupied with their home trade, but the serious under-cutting which prevails between British makers and suppliers has given rise to much serious discussion. This under-cutting has been proceeding for several years, and its effect has been very evident in nearly all the reports of electrical manufacturing concerns. The output capacity of the works is, for the time being at any rate, in excess of the requirements, and the successful future seems to lie in developing electrical enterprise in foreign markets. Much is proceeding in this direction at this moment. The profit obtainable upon municipal electrical contracts has been so greatly reduced by the competition in price-cutting, that some firms have expressed the intention of not wasting time and energy in trying to secure such business. But there is a movement on foot among a number of manufacturers to adopt concerted action for protecting their interests by raising prices. Whether this movement will be more successful than some that have preceded it is hard to say, but it certainly at the moment gives promise in that direction.

America has given us a good lead by the organization of its Illuminating Engineering Society. The attempts to form a similar society in London have apparently not yet been successful, but the need for illuminating experts to guide consumers in securing better lighting efficiency is very real and is becoming more and more recognized. The difficulty of educating the consumer was interestingly dealt with by James Swinburne, F.R.S., on November 14, in a valuable communication to the Association of Engineers-in-Charge, in London. "Indoor Illuminants" was the title, gas and electricity mainly being considered. Though the modern central station is a marvellous study of economical production all questions of economy end at the consumer's meter. "He uses blackened lamps, which are marked incorrectly to begin with, and he covers every light with useless and dirty shades, and has his lamps in the wrong places." "But," said Mr. Swinburne, "the average man is busy all day, and you can not expect him to spend his evenings puzzling out questions of photometry or luminous efficiency." The engineer-in-charge who has to look after the lighting of a big building was advised to become a specialist to some extent in illumination. Though we may some day have illuminating engineers who will be tied to no particular system but will deal with each on its merits without partiality, the matter to-day is left mainly to chance, with some assistance from architects and house decorators. From the physiological point of view, the speaker said, the sources of light should not be intense, but should be small and numerous, or out of sight. As to color, it should be as near sunlight (as it reaches the earth) as possible, which view was supported by the experience of the users of the mercury arc, which, though it made things look "very ugly" as far as color went, was very restful to the eye, and was specially useful in drawing offices and similar places. The illumination of buildings was dealt with in two classes: (1) general; (2) special; and something was said regarding cost comparison of gas with electricity. Gas lighting with mantles was stated to be very much cheaper than any other form of indoor lighting except the mercury lamp. Mr. Swinburne's comments on the metallic filament lamps may be quoted: "We might almost put the carbon lamp on one side, because it appears to be doomed, as the metal wire lamps seem bound to push it out of existence as soon as they can be made in large enough quantities, and, what is more important, as soon as the public gets into the habit of asking for them. They are far more efficient than the carbon lamps, but they have some special drawbacks of their own. Some do not work well on alternating circuits. This is a difficulty that exists in some lamps only and will most likely soon be overcome. The other and very serious difficulty is that it is apparently impossible to make small lamps for reasonably high pressures."

The Institution of Electrical Engineers (London) on November 8 listened to the presidential address of Dr. R. T. Glazebrook, of the National Physical Laboratory. Electrical standardization and units were the chief subjects touched upon. At the Leeds section the chairman, George Wilkinson, in his opening address put forward some of the problems that had crossed his path as a supply station engineer, and discussed some suggestions for their economical solution. The president of the Birmingham section, R. A. Chattock, delivered his address on November 21, devoting it to considerations which had governed the development of electricity supply. Among other things he congratulated Birmingham upon having delayed such development until now, because it had thus been able to watch how it proceeded in other large centres of commerce. It was thus able to adopt the most modern and efficient plant and design. On November 13 at the Glasgow section a joint contribution by Professor F. G. Baily and W. S. H. Cleghorne on "Some Phenomena of Commutation" was read. A description was given of experiments on the phenomena occurring in the process of the commutation of armature currents in direct-current dynamos and motors. Some of the work so described was substantially a repetition of earlier work, but amplified to more exact determinations, or carried out in a different manner. The points discussed in the paper were: The contact resistance of the brush, the value of the brush current, the currents in the short-circuited coils, and the electromotive force between the segment and the trailing edge of the brush. The Leeds section, already mentioned, has been considering the question of overhead equipment for tramways. R. H. Campion, who introduced the subject, gave figures relating to cost of maintenance of overhead lines at a number of places. He thought trolley wheel grooves should be made wider than was customary and slightly V-shaped at the bottom; and pointed out various advantages of the bow collector as compared to the trolley wheel. These advantages included diminished wear on the wire when rounding curves, simplification of overhead construction, freedom from jumping the line, and ability to run in either direction. He wanted to see some engineer adopt the bow collector on a new line, for he felt that these good points had been overlooked.

For some time past good progress has been made with the erection of the new magnetic observatory at Eskdale Muir, in Dumfriesshire, but it is now reported that work has had to be stopped for the present. The building is under ground, and it is thought that there is iron in the blue whinstone that is being used. The erection of the other buildings is proceeding.

ALBERT H. BRIDGE.

London, November 24, 1906.

The Pennsylvania and the Baltimore & Ohio Railroads have informed the District Commissioners that they can not substitute electric motors for steam locomotives within the District of Columbia. The Commissioners requested that this be done from the time the new union station is in use.

The Faraday Society.

The twenty-third ordinary meeting of the Faraday Society was held on Tuesday, November 13, at the Institution of Electrical Engineers, London, England. Dr. F. Mollwo Perkin, treasurer, was in the chair.

W. Pollard Digby read a paper entitled "Some Investigations Relative to the Depreciation of Electrolytically Produced Solutions of Sodium Hypochlorite."

This deals in the first place with depreciation taking place in bottles of various colors in which dark amber bottles gave the best results, the loss in 1,817 days being about forty per cent for a solution containing 4.216 grammes of available chlorine per litre. The corrosive action of hypochlorite solutions upon various metals is then discussed, and the depreciations due to graphite, copper, zinc, lead and iron plates immersed in such solutions are set forth for a period of 480 hours. A much greater depreciation takes place, due to galvanic action, when two dissimilar metals immersed in the liquid are connected by an insulated wire: the paper gives records in the case of twenty-one different couples. When iron is present as one metal in such a couple, the depreciations are generally greater than for any two other metals.

As regards the area of the exposed surface in the cases of single metals immersed in hypochlorite solutions, it was found that doubling or trebling the surface doubled or trebled the rate of depreciation.

Brief reference is made to the value of protective coatings as applied to metal-couples, but no conclusive results were obtained.

As it is a matter of difficulty to paint evenly the inside of small plates, and, still more, of pipes, the writer deprecates reliance upon insulating materials for the protection of any vessel in which hypochlorite liquids are stored, or of any metallic piping in contact with hypochlorite liquids. When once the paint breaks down, corrosion of the metal will follow at a rapid rate.

Accounts are also given of the value of bitumen as a protective agent for wood exposed to hypochlorite solutions.

In conclusion the author urges that storage, transport, and methods of conveyance from place to place, or even from one part of a factory to another, are details meriting attention. Certain conditions of storage may clearly be regarded as fatal to stability, particularly those in which the galvanic action of dissimilar metals is likely to arise.

Chas. V. Biggs read a paper describing "The Hermite Electrolytic Process at Poplar."

This paper is a contribution to the data at present available on the subject of the electrolytic productions of hypochlorites. It consists of a description of the plant in use at Poplar for the preparation of a solution containing about 4.5 grammes of available chlorine per litre, for use as a disinfectant in the borough.

The system adopted is to mix a certain quantity of fluid in an elevated tank, and then to allow this fluid to flow through four double troughs or cells, placed one above the other so that the liquid descends, continuously by gravity. Each trough is divided laterally by a partition, and in each of the two divisions five distinct "elements" are suspended. The positive plates are of thin platinum wire wound upon slate slabs and the negative plates are of zinc. There are thus four troughs each containing ten "elements," or forty cells in all. After passing through the successive cells, the liquid discharges into a carboy. Sodium hydroxide is used as a preservative; it flows drop by drop into the carboy as it is filling and serves to neutralize free hypochlorous acid. As the liquid passes through the troughs it is subjected to the action of a current of fifteen amperes at 230 volts, being 5.6 volts per cell.

The tank is charged by placing in it 100 litres of a saturated solution of sodium chloride and twenty litres of a saturated solution of magnesium chloride. To this is added as much water as will bring the whole up to 840 litres. The rate of flow through the apparatus is three-and-one-third pints per minute.

Curves are appended showing (1) the rise in value of the solution as it passes through the cells, amounting to about one gramme per litre for ten cells; (2) efficiency in grammes per British thermal units for this plant, which is highest at a current of sixteen amperes. Above this amperage energy is wasted in heat, and below it the flow becomes too high.

A number of tests of samples of the liquid made are given. Liquid made during the warm weather of the exceptional summer of 1906, at a temperature of 104 degrees Fahrenheit, was found to have lost only 0.1 gramme available chlorine per litre in six weeks. Several samples of liquid made before the conditions of the plant (as to mixing, rate of flow, etc.) were very fully determined, showed losses of 0.1 and 0.2 grammes per litre in six months; the higher strengths (4.8 to 5.3 grammes per litre) losing 0.5 grammes in six months.

The author concludes that the magnesium hypochlorite, as made at Poplar, is sufficiently stable for practical purposes, and that it could be made in a warm climate without necessarily rapid deterioration. The warm weather specimens quoted had been kept in ordinary dark glass bottles, merely corked.

J. B. C. Kershaw considered that electrolytic hypochrolite was unlikely to replace bleaching powder at present prices. He criticized the efficiency of the Hermite plant at Poplar.

Dr. R. S. Hutton hoped that further information regarding the electrodes and other important details of the Poplar plant, and also further data regarding cost and efficiency would be forthcoming. He drew attention to the theoretical work that had been done on the Continent. Replying to Mr. Kershaw's strictures, efficiency depended on concentration. At Poplar high concentrations were used, so the efficiency was relatively low.

Dr. F. W. Alexander gave complete details regarding the cost of running the Poplar plant. The plant has been producing an average of 200 gallons a day of 0.4 grammes solution since January last at a total cost for current and material of under £33. Two laborers sufficed to watch the plant and bottle the solution. The defects of the original Hermite process had been successfully overcome. They had no trouble with non-conducting films on the zinc cathodes. Non-stability was caused by the presence of undecomposed salt in solution.

Dr. S. Rideal was of the opinion that the convenience of being able to make hypochlorite on the spot as required for disinfecting purposes rendered it far more suitable than bleaching powder. The dust nuisance caused by motors rendered the use of a sterilizing fluid for street watering a necessity.

L. A. Smart remarked on the value of such electrochemical processes to borough engineers if they could be arranged to run so as to increase the load-factor of the power station.

W. Defries pointed out that although the price of raw materials would probably not decrease, that of power tended to diminish, so electrolytic hypochlorite would in time compete favorably, even as regards price, with chloride of lime.

The authors' replies were reserved for the transactions. The paper by Dr. Alex. C. C. Cumming "On the Electrochemistry of Lead," was taken as read, and the discussion postponed until the December meeting.

Report on the New York Telephone Situation.

Harry P. Nichols, assistant engineer of the Bureau of Franchises of the city of New York, has filed his report with the secretary of the Board of Estimate and Apportionment on the result of the investigation which he has made of telephone conditions throughout the country in cities where two telephone systems are in operation.

This investigation was made under the direction of the Board of Estimate in view of the application of the Atlantic Telephone Company for a franchise to operate in this city.

After covering in a general way telephone conditions in the various sections of the country where investigations were made, Mr. Nichols takes up under separate headings the subjects which he thinks should be taken into account when considering a franchise for a second telephone company to operate in New York city.

Mr. Nichols defines the two methods of charging for telephone service, the flat rate being a fixed charge per month or per year for the use of the telephone, regardless of the number of messages sent; the measured rate, a charge based upon the number of messages used. Concerning the flat-rate plan, he says "that this system is unfair to many subscribers is universally conceded."

Mr. Nichols states it is his belief that the matter of rates and their effect upon the financial prosperity of the company offering them demands the most careful consideration by the city in fixing the terms of a franchise.

Referring to the proposed rate schedules of the Atlantic Telephone Company Mr. Nichols says: "I believe the rates offered have not been carefully prepared, which would seem to indicate that the company has not made an exhaustive study of the cost of equipment and operation upon which to base such rates. No rates are given for private branch exchanges and extension stations, which I believe should be specified in the contract."

Mr. Nichols states that from information received in other places, he believes the charges for suburban and long-distance service in New York to be too high.

Mr. Nichols states that while two telephone systems where tried have resulted in an increase in the number of telephones, with a general improvement of service and lowering of rates by the old company, this has been attended by inconvenience to subscribers and by additional expense to those who have felt that they must have both telephones in order to get a full service.

Mr. Nichols feels that the effect of competition on the Bell companies has been to create a new ambition on their part to enlarge and develop their system. He states that in 1899 the total number of Bell telephones in operation in this country was less than 500,000, while on January 1, 1906, there were more than 2,530,000 Bell telephones in operation.

Mr. Nichols states that many contradictory statements were made in regard to the effect of independent telephone companies on the Bell companies' rates, the independent companies claiming that the effect was to force a general reduction in the Bell rates, and the Bell companies claiming that no reductions were made on account of competition, the rates having been reduced from time to time as the companies' earnings warranted. Mr. Nichols thinks that the independent companies have been in the main responsible for these rate reductions.

Mr. Nichols thinks that competition has raised the standard of efficiency of telephone service generally.

The report takes up in detail the subject of automatic telephones. Regarding the application of this information to New York conditions, however, he says as follows:

"Several exchanges were visited where the automatic system is in operation. However, no exchange examined is of much use in determining how such a system would apply in New York, in which a number of exchanges will presumably be necessary within each borough. In none of the cities visited was there more than one exchange in operation."

Mr. Nichols points out the danger of overcapitalization of telephone companies, and compares the capitalization of the Bell Telephone Company, of Buffalo, and the independent companies operating in that territory, *i. e.*, the Frontier Telephone Company and the Rochester Telephone Company, showing that the first is capitalized at $124 per telephone, while the independent companies are capitalized at $288 per telephone.

In his conclusions Mr. Nichols states that in his opinion the telephone companies in New York are doing everything in their power to increase the telephone development of the city; that the service is equal to, if not better than, that of any other manually operated system; and although reductions in rates have been made from time to time, he believes that the board should undertake an investigation to ascertain whether the present rates are as fair and as low as they should be. He states that the officers of the New York Telephone Company and the New York & New Jersey Telephone Company have expressed their willingness to cooperate with the board in such an investigation.

CONCLUSIONS.

In closing his report, Mr. Nichols makes the following recommendations:

First: That the board consider the offer of the New York Telephone Company and the New York & New Jersey Telephone Company, as contained in their communication of July 13, 1906, and direct that an examination be made of the property and financial affairs of the companies to ascertain if the amounts offered to the city for the exclusive right to a telephone business are adequate, and if the rates now charged are fair, such examination to include the relations of these companies with the American Telephone and Telegraph Company, a New York state corporation, known as the parent company, and under whose license the New York and the New York & New Jersey companies are now operating.

Second: That the matter of the Empire City Subway Company (Limited) as contained in the communication from the telephone companies be referred to the corporation counsel with a request to take up the matter immediately and confer with the representatives of the telephone companies, and advise the board as soon as possible if, in his opinion, a settlement of this case can be obtained which will in all respects protect the interests of the city.

Third: That the Atlantic Telephone Company be requested to present a study for an automatic telephone system in the city of New York of a capacity such as it proposes to install, together with detailed plans of mode of construction and operation. Further, that a detailed statement showing the estimated cost of the proposed installation, operation, maintenance and expected depreciation be submitted. Such statement to show the amount of capital, in the opinion of the Atlantic company, necessary to successfully finance the operation, and the extent to which it is proposed to bond the company should a franchise be secured. That the system of rates for toll business and subscribers' stations, as contained in the proposed form, be revised, and that rates for private branch exchanges and extension stations be added.

If such an investigation be made of the Bell companies it would show the cost of plant, the operating expenses and earnings of the manual system in the city of New York, and it would seem that the board should then be in a position to more intelligently decide upon an application from an independent company which offers rates far below the existing tariffs. If such an independent company desires to use the manual system a direct comparison could be made, and the board would be enabled to determine if an independent company entering the field could live under the rates offered and the terms proposed in the forms of franchise now before the board.

It should be remembered that in the statements made in favor of the automatic system the cost of installation and of operation would have a direct effect upon the cost of service of that system, if the municipal authorities retain the power to fix the rates by the terms of the franchise. Such provision has been proposed and accepted by the Atlantic Telephone Company in the form of contract previously submitted to the board.

It is extremely important that every effort should be made by the board to ascertain not only what a company applying for such a privilege is willing to do, but also what it is able to do before action is taken upon an application which affects so large a proportion of the inhabitants of the city.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Cost of Suction Gas Power.

In this communication W. A. Tookey gives the log of a small suction gas producer plant from the beginning of the present year up to the latter part of October. The plant consists of a twenty-horse-power engine drawing its gas from a suction producer, and driving by chain belt a dynamo. The plant is in charge of a man who is employed at other duties, and previously had no knowledge of gas engines or gas producers. The chart shows the ordinary output of the generator, the coal consumption and the fuel cost per unit generated. The producer was operated at times for six weeks without stopping. The engine is frequently started some time before the load is thrown on the generator, so that the system is not operated in the most efficient way, considered from the fuel consumption point of view. The chart shows that with an output of 500 kilowatts the coal consumption was 1,100 pounds. The cost per kilowatt-hour for fuel alone was then 0.6 cent. When the output fell to 180 kilowatts the coal consumption was 540 pounds, and the cost of fuel per kilowatt-hour was 0.8 cent. These are the extreme figures. The average cost for the nine months was 0.73 cent per kilowatt-hour. Allowing for depreciation and service it is estimated that the cost per kilowatt-hour of this small plant was not more than three cents.—*Abstracted from the Electrical Review (London), November* 16.

Mules and Electric Locomotives.

A comparison is made here by W. F. Murray of the cost of mine haulage by mules and by electric locomotives. The chief advantage in using mules lies in the fact that the mule can enter any portion of the mine unhindered, while the electric locomotive can not leave the trolley, except by means of a cable reel. Another fact worthy of consideration is the difference in the weight of the rails that may be used in each system. Sixteen-pound rails may be used for mule traction, while thirty-five-pound rails are necessary for electric traction. Further, with the latter system rails must be bonded. On the other hand, mules can not be used in the low-vein mines, as there is not sufficient height. Also, each mule requires five times as much air as a man, so that removing fifty mules from a mine would make possible the addition of 250 men without any increase in the ventilating system. Mules further make a rough roadbed, wearing out the ties and making drainage difficult. The average life of a mine mule is from seven to ten years, while that of a locomotive is twenty-five years. An example is taken in which fourteen mules are replaced by a single locomotive. The cost of the mules and harness is $2,870. The working expenses, including care of the mules, drivers, interest and depreciation, are $6,577, so that the cost of hauling the 367,500 tons yearly load delivered by these animals is 1.8 cents per ton. The electric locomotive and generating apparatus would cost $11,200. The working expenses, including interest and depreciation, are $4,617.50. This locomotive would haul the same amount of coal as the mules, and the cost would be only 1.27 cents per ton. No allowance is made here for the cost of the stable for the mules nor for losses by accident.—*Abstracted from the Engineering and Mining Journal (New York), November* 24.

The Production of Radium from Actinium.

It is generally stated that radium is a decomposition product of uranium, but all the facts known regarding this change have not been in agreement with this idea. Both Soddy and Whetham have stated that they observed an increase with the time in the amount of radium in solutions of certain uranium salts which were under examination. B. B. Boltwood was able to show that, starting with a solution of uranium nitrate carefully purified by repeated crystallization, the amount of radium formed in an interval of eighteen months was less than one-two-thousandth of the amount which was to be expected from the disintegration theory. He here offers an explanation of this discrepancy, which is based upon a recent experiment made on the growth of radium from actinium. A kilogramme of carnotite ore containing about twenty per cent of uranium was decomposed with an excess of hydrochloric acid. This solution was then treated to separate the actinium from the other constituents. It was secured in the form of chloride, which was then sealed in a glass tube. This was allowed to stand for two months, when the gases contained in the tube were removed and introduced into an electroscope. The activity of the emanation was then determined. The tube was then sealed and allowed to remain undisturbed for several months longer. The emanation was again removed, and it was found that the activity as compared with the former corresponded to an increase of nearly three times in the content of radium. From the rate of increase it is computed that the indicated half period for the evolution of the emanation would be about 3,100 years, though this figure is only approximate. The author thinks that these facts constitute another step toward the solution of the somewhat complex problem of the genesis of radium, and since the amount of actinium in a mineral is apparently always proportional to the amounts of uranium and radium present, that actinium will prove to be the looked-for intermediate product.—*Abstracted from Nature (London), November* 15.

Some Measurements of Phase Displacements in Resistances and Transformers.

Dr. C. V. Drysdale has been investigating the problem of measuring small phase displacements. He here gives a description of one method which has been found very accurate. The device, the effect of which is to be investigated, is connected in series with a non-inductive resistance across one phase of a two-phase system. In parallel with it is a high-resistance shunt provided with a slider for making contact at any point. This slider is connected to one pair of quadrants of an electrometer, the other pair being connected to the point intermediate between the device under investigation and the non-inductive resistance. A high-resistance shunt is connected across the quadrant of the electrometer, and the central point of this shunt is connected to one terminal of the secondary of a step-up transformer,

the other terminal being connected to the electrometer needle. The primary of this transformer may be connected to either of the two phases of the supply. To make a measurement the slider on the high-resistance shunt is moved until the electrometer needle stands at zero. The transformer primary during this measurement is connected to the phase of the system which supplies the load. Readings are then taken of the position of the slider. A second reading is taken with the transformer primary connected to the other phase. This gives a deflection of the electrometer needle proportional to the voltage across the load. With these readings it is possible to construct a voltage triangle, because it is known that the potential across the load and that due to that section of the high-resistance shunt corresponding to it form the base and hypothenuse of a right-angle triangle. The diagram, when laid off, at once shows the angular displacement of the load current. A modification of this method is given, which avoids errors due to inaccuracies of the electrometer. The method is accurate, enabling the angle of displacement to be determined within a small fraction of one per cent. Some figures are given showing the application of this method to various devices. No. 10 standard gauge wire, wound in spirals about one inch in diameter, with three-eighths-inch pitch, gives an angle of lag at fifty cycles of from sixteen to eighteen degrees. Resistances of Constantan strip, wound in spirals of about one-half-inch diameter, show an angle of lag of less than one-tenth degree. Incandescent lamps with ordinary looped filaments may be regarded as absolutely non-inductive at fifty cycles, as no angle of lag was noticeable, although a displacement of two-hundredths of a degree could have been detected easily. Interesting results are also given showing the effect of various liquid resistances. Various experiments with one solution do not give results agreeing entirely, but the difference is attributed to changes in the electrolyte, and not to the method. Lead plates in dilute sulphuric acid, at a frequency of fifty-three cycles per second, show angles of lag varying from two to five degrees. In caustic potash the lag was less than one degree. In caustic soda it varied inversely with the density from one to three degrees. Iron in caustic soda gave an angle of lag of less than one degree. Aluminum in caustic soda gave angles of lag varying from thirteen degrees down. The general conclusions from the measurements of liquid resistances are that in all cases, except where aluminum electrodes are employed, the power-factor is unity within one-half per cent, or less. In the case of regulation tests, however, the two or three degrees of lead which may be introduced by liquid resistances may appreciably improve the regulation of an alternator above that on an absolutely non-inductive load. Iron wire coils are appreciably inductive at ordinary frequencies. The large angle of lead produced with aluminum electrodes may make them of decided value for induction motor starters.—*Abstracted from the Electrician (London), November* 16.

A Method of Producing Undamped Electrical Oscillations, and Its Application in Radiotelegraphy.

At a recent meeting of the German Electrotechnical Society, Valdemar Poulsen described the work which he has been conducting for several years past with the singing arc, the object being to obtain a means of setting up undamped high-frequency electrical oscillations. The singing arc, as described by Duddell, consists of an arc struck between two electrodes, which is shunted by a circuit containing inductance and capacity. This system will set up electrical oscillations through the shunting circuit and the arc, which produce, under certain conditions, a musical note. By changing the constants of the shunting circuit the frequency may be changed. The frequency is also affected by the conditions at the arc itself. Duddell succeeded in obtaining a frequency of oscillation of 40,000 per second. This is too low for use in radiotelegraphy, and it has been Poulsen's endeavor to increase the frequency. Various modifications have been tried. It was found that the gas through which the arc passed affected the frequency enormously. The first work was done by striking an arc through a flame such as is given by a spirit lamp, but it was found that hydrogen gas gave the best results, particularly if it contained a little hydrocarbon vapor. By this means frequencies up to 700,000 a second have been obtained. The next step is to maintain the frequency absolutely constant, in order that the full benefits of tuning may be obtained. To do this it is necessary to maintain the arc in a fixed position and of fixed length. The former condition is secured by placing it in a magnetic field which holds it steadily at the upper edge of the two electrodes placed horizontally. To maintain the length constant the positive electrode is made of copper and cooled by water circulated through it. This electrode is tipped with a copper ring, which is easily removed if it becomes roughened. The negative electrode is of carbon, considerably larger than the other, and is cut so as to present an acute angle at its edge, the end of the electrode being slightly concave. This electrode does not wear away, but grows slightly, due to the deposition of carbon from the surrounding vapor; and to maintain the distance between the electrodes absolutely constant the carbon electrode is revolved slowly. If desired, a knife may be placed for trimming off the deposit formed. This arrangement gives oscillations of fixed and very high frequency. The oscillating circuit is coupled to the sending antenna. The coupling preferred is that known as loose, for while this is more wasteful of energy than a close coupling, the frequency of the oscillating system is not so much affected by those of the auxiliary circuits. To obtain a higher voltage than that given by the simple oscillating circuit a second circuit is connected in parallel with the first, but with the apparatus arranged in the reverse order. This gives practically double the potential. A number of experiments have been made by Poulsen with this apparatus. It was found that great distances could be covered with a small generating set. For the receiver an oscillating circuit, loosely coupled to the antenna, was used, a telephone being connected across the capacity. In series with the telephone was a device called a "tikker," the object of which was to avoid the damping effect on the receiving oscillating circuit due to the telephone. This circuit is allowed to oscillate until considerable energy has been set in motion; then the "tikker" closes the telephone circuit, producing a sound in this instrument. Transmission was easily secured across Denmark, a distance of about 200 miles, with an energy output of 700 watts, 100 of which was transformed into electric waves. Later, messages were easily sent several thousand kilometres over water, the energy consumption being 2,800 watts. The system is suitable for producing wave-lengths varying from 1,000 to 10,000 feet, and as neighboring stations may operate without interference if more than one per cent out of tune, there is a possibility of operating 100 stations in a given district.—*Translated and abstracted from Elektrotechnische Zeitschrift (Berlin),* November 8.

Methods of Getting New Business

A DEPARTMENT DEVOTED to the COMMERCIAL DEVELOPMENT of CENTRAL STATIONS

Managers are Invited to Contribute Suggestions for Methods of Increasing the Demand for Electric Service

The following article is one of a series of four by Frank B. Rae, Jr., which will be published in the ELECTRICAL REVIEW. These articles will form a coherent analysis of a number of important phases in central station publicity methods. The subjects which will be discussed in future articles are as follows:

Article II, ORGANIZATION OF SOLICITING FORCE—Personnel of soliciting force; system of reports; solicitors' meetings and education; display room and its relation to soliciting work; cooperation between solicitors and advertising.

Article III, ADVERTISING COPY—Different kinds of copy; publicity; announcements; "reasons why," and other styles in advertising copy.

Article IV, ADVERTISING COPY—Circular letters; booklets; folders; mechanical details; pictures and engravings; printing and papers; useful hints.

ADVERTISING ELECTRICITY.

BY FRANK B. RAE, JR.

The following series of articles does not constitute a guide of "how to advertise successfully." There is no royal road to advertising experience. It is not a trick to be learned from books nor by correspondence. On the contrary, it is a life-study, to be approached with the same reverence and earnestness which any profession demands. The object of this writing is to clear away some of the mists which envelop this subject of advertising in the minds of those unfamiliar with it except in its superficial manifestations. The writer will, if it be possible, awaken an intelligent interest in, and appreciation of, the underlying principles; an understanding of the amount of labor and concentration necessary to be expended in plans and preparation before any advertising campaign can hope to merit or attain practical success.

The ultimate object of advertising is profit. It is not, as some casual observers appear to believe, simply a device to get more business. It is a system to secure more profit. Net profit, not gross income, is the figure which interests the business man and the investor. Looking at it from this angle, advertising is a subject of the utmost importance to any electric light company whose load curve is anything but a horizontal line.

THE ELEMENTS OF ADVERTISING.

What advertising is is largely a matter of opinion. To one of average inexperience in such matters, central station advertising consists merely in a quantity of more or less interesting and artistic printed matter, in newspaper announcements and in posters upon hoardings or within street cars. But to the man versed in the art of turning public opinion into dollars the advertising of electricity is a subject of almost unbelievable complexity. It begins with the placing of orders for prime movers and generating machinery and permeates the entire system and organization of the lighting company from the coal pile to the lamps and motors—from the obscurest shareholder to the president of the company, and so on down to the very arc-lamp trimmer. And it is this very difference in viewpoint upon the part of the advertiser which marks the difference between good central station advertising and that which fails of its mission. The inefficient advertising is based upon superficialities; effective advertising takes account of whatever is germane to the commodity advertised and concerns itself quite as much with subjects of company policy and politics as with the preparation of plates and printing.

Eminent authority has stated that advertising is at present an art, having not as yet reached a place where it may be accepted as an exact science. It must be noted, however, that even considering it as an art the professional practitioners, especially those familiar with the ethics and more common technicalities of central station practice, have a very decided advantage over those who may fitly be termed amateurs. Further, it may safely be set down as a truism that, while some men unpractised in this art of advertising may attain successful results, the advantage lies most decidedly with those who, through experience in handling similar problems, can tell, within very close limits, exactly what results accrue from a given method of procedure. Advertising experience costs money, and advertising ability costs years of training and study in addition to natural aptitude. Nowadays it is cheaper to hire experience than to buy it blindfolded.

The most common and at the same time the most altogether inexcusable error made by those entering the advertising field for the first time is that of beginning to spend money before giving due study to their business as an advertising proposition. This mistake takes the common form of the hurried issuing of a few disjointed circulars, or the insertion in newspapers of a statement reading "Use Electric Light." Returns upon these tentative efforts are awaited with feverish anxiety by the amateur advertiser, and the limited results obtained too frequently lead the experimenter to abandon publicity work as futile. The time factor alone would preclude its success. Not alone is such abortive advertising undertaken wholly without proper study of conditions, but it is frequently patterned after or copied from the work of some other company, the advertiser expecting to accomplish without sufficient preparation, by the use of what might be characterized ready-made or second-hand material, and at infinitesimal expenditure, what one experienced in the art and with an eye to every circumstance and contingency could not hope to accomplish. Time is a factor in all advertising. Even the so-called "mail-order" propositions expecting instant cash-with-order replies gain momentum as they continue. How absurd, then, to expect returns upon a two-time trial, or even upon less than a six-months' effort in advertising electricity.

THE STUDY OF LOCAL CONDITIONS.

No central station advertising should be undertaken without a most thorough and disinterested canvass of local conditions. To make such a canvass effective requires a species of impartiality almost superhuman, in that the man undertaking it must criticise himself, his company and his service from the cold and indifferent viewpoint of the disinterested public.

Upon this rock founders many a good central station advertising project. Not one man in fifty has the moral courage to look his business fairly in the face and admit its shortcomings. Yet it must be done, for to solicit increased patronage it is imperative that the present consumers be satisfied. To appeal to the public for support the company must deserve support. This frequently means that before an advertising campaign can be undertaken both the physical and moral equipment of the lighting company must undergo a vigorous and often an unpleasant rejuvenation, if not an actual reform. The advertiser must make it his business, first and foremost, to place himself and his company in such position that the public can not question either his commodity or his good faith. He must realize that advertising is merely the process of molding public opinion into a condition favorable to the advertiser and his goods. He must realize that he can not successfully and favorably mold public opinion so long as a reasonable excuse for prejudice and adverse criticism exists.

While it is no part of our business to discuss specifically the questions which will naturally be raised in the reader's mind by this statement, it may be suggested that the subject very naturally subdivides under such headings as: equitable rates, courteous treatment and good and continuous service to present customers, the prompt serving of all who may contract for future service, an accessible and inviting room for the transaction of business with the public, and a staff of solicitors and office assistants qualified to deal with that public intelligently and with unvarying tact and courtesy. The satisfactory solution of the problems which will come within the bounds of these subjects may be considered as preliminary to any active campaign of advertising, and this for the simple and very natural reason that the disregarding of any one item mentioned will partially or wholly neutralize the most skilful and enthusiastic effort of the most practised advertising man.

When such measures have been instituted as will make certain the prompt, efficient, courteous and equitable serving of the public, the lighting company is ready to consider the subject of advertising as the term is ordinarily used. It has provided for the effective handling of the business that must inevitably result from direct advertising effort. It has taken care of those items known as indirect advertising. Let us now turn to the more interesting, though really less important problems of actual business-getting—of salesmanship, personal and on paper.

PLANNING A CAMPAIGN.

First there must be a plan. The preliminary canvass of local conditions should have indicated exactly what class or classes of lighting or power business may be most desirable and profitable, and how much of each of these several classes can, at reasonable expense, be procured. Basing the careful estimates upon the probable net increase, it becomes necessary to decide how much money should be spent in the advertising and soliciting of this trade. Upon the amount of the appropriation depends almost entirely the plan, for in advertising is to be found one of the few cases where the basis of trade lies rather in the purchaser's pile than in the seller's price. The plan must be made to fit the appropriation unless the field is so large and the amount of surplus energy for sale so nearly unlimited that the appropriation can be made to fit any reasonable plan.

The backbone of any plan of campaign for selling electricity lies in the soliciting force. It must be self-evident that electric current can not be sold by mail or by any of the devices employed to secure what are known as "direct returns." The closing of every sale lies with the solicitor, and our advertising campaign can, at best, only assist by broaching the subject of electric service to the prospective customer, presenting and arguing its fundamental advantages and bringing him to the point of so far committing himself as to ask for a personal interview with the contract agent. The first question, then, is how many solicitors can be profitably employed? In this, as in other analytical questions connected with business-getting departments, preferences and prejudices must be cast to the winds. Only so many solicitors should be taken on as can be kept actively at work all of the time. Few solicitors rather than many should be the main idea—few solicitors, and let them be thoroughly competent and well paid. It is a serious mistake to employ "card presenters" in such work. Cheap men cost more than good ones.

Having set aside the amount necessary to take care of the soliciting force, the balance of the appropriation should represent what may be spent for the real advertising. The problem instantly resolves itself into a question of what kind of advertising can most profitably be undertaken; and this question brings us to the consideration of the several methods of publicity in vogue—newspaper advertising, bill-boards and street-car cards, and direct advertising.

SUBDIVISIONS OF ADVERTISING.

As to the actual value of newspaper advertising for electric light and power business there is a vast difference of opinion. One man, well known in the field of central station advertising, when asked what effect his campaigns of newspaper publicity were giving, replied with a shrug of the shoulders. Others, on the contrary, contend that it is the only "safe-and-sane" method of reaching the right people. It is very probable that the truth of the matter lies between these two extremes and that local conditions should be permitted very largely to govern the extent to which the press is used. To most men the main factors in newspaper advertising are very naturally copy and circulation. But good copy in representative mediums is only a part of the newspaper proposition. Editorial and news cooperation is necessary. It is obvious that a large percentage of newspaper circulation goes to people who could not by any possibility become customers of the electric light company, either through lack of means or their location of residence. On the other hand, newspapers are read with extreme care by certain classes which the contract agent is anxious to reach—notably merchants, who study the newspapers, not alone to read their own advertisements, but the advertisements of their competitors. The newspaper which reaches the better classes of homes is also a profitable medium, but it must be remembered by the advertiser in charge of a central station appropriation that he can not discriminate between mediums, as can a merchant or manufacturer, but must use all, lest he incur enmity and consequently call down upon his company the abuse of some.

On the subject of bill-boards and street-car cards, very little need be said. These constitute in the broadest sense general publicity, the results of which can be traced only from the general attitude of the public toward the company or commodity advertised and a healthy increase in business. It is the writer's conviction that street-car cards are wholly unprofitable except where the electric light company and the traction company are combined and control space in their own cars. In such cases the space is likely to be cheap and the company can perhaps afford to use it.

Direct advertising, the third and most important division of the means of molding public opinion, subdivides under many heads and includes anything that can be

sent by mail, from personal letters to elaborate books. Circumstances must dictate to what extent and in what variety this material is used, the only fixed rule being that it must be used systematically and continuously, and not in a haphazard manner. The keynote of direct advertising lies in system. The campaign must be carefully planned, closely followed up and vigilantly watched. This does not mean that a cut-and-dried routine should be established and a certain fixed advertising policy maintained in the face of unexpected circumstances. On the contrary, the greatest flexibility should obtain in the campaign. But it is essential that approximate dates for the mailing of advertising should be adhered to, and sufficient persistence and insistence be employed to ensure adequate results. Tentative efforts are futile. Disjointed and disconnected material confuses the prospect without convincing him on any single point. Only systematic, persistent presentation of the proposition, each mailing supplementing the last and complementing what follows, will develop customers.

The advantage of direct advertising for an electric light company lies in the fact that it is possible to secure accurate lists of bona-fide prospects. We say "possible." It is only too easy to have lists which are anything but accurate, and this in the face of very honest endeavor. The need of good lists will appear self-evident. It is worse than useless—it is damaging—to send a series of letters and other advertisements to people who can have no possible use for your product. To exhort a man to use electric power when he has absolutely no use for power of any kind gives the impression that the company is remarkably careless, and that this carelessness doubtless extends to the meter and billing departments. If, at a later date, this same individual is approached on the subject of lighting, he will be doubly indifferent to the appeal. Again, advertising costs money. To waste the one is equivalent to wasting the other.

The actual preparation of direct advertising hinges wholly upon local conditions. Generalities no longer convince. The public is "wise." This fact, as has been pointed out by one of our leading textbooks on the subject, makes present-day advertising success at once easier and more difficult than similar success a few years back. To-day we must get at the very heart of our subject and demonstrate its advantages by a species of vivisection. The advertiser who can do that clearly, tersely, sustaining the reader's interest and convincing him by logical presentation of fact, is absolutely assured of success.

The American Institute of Electrical Engineers' Land and Building Fund.

The announcement recently of the large donations from George Westinghouse, representing the various Westinghouse interests, of $50,000, and from the Allis-Chalmers Company, of $3,500, to the land and building fund for the Engineering Societies' Building, has stimulated interest among electrical engineers in this undertaking.

Contemporaneously with this announcement the Land and Building Fund Committee of the American Institute of Electrical Engineers has issued the following appeal, dated November 24:

DEAR SIR: You will be glad to learn that the Land and Building Fund Committee of the Institute, appointed for the purpose of raising $200,000 to provide for our share of the necessary real estate and equipment for the Engineering Societies' Building, given us by Mr. Andrew Carnegie at a cost of over $1,000,000, has already secured subscriptions to the amount of $150,000 and has collected nearly $100,000 of that sum, the other portion being due in yearly instalments. Contributions to the fund from individual members, aside from corporations, have ranged from $5,000 to $5.

The building is now practically complete and the administering body, the United Engineering Society, has notified the prospective occupants of the building that it is available on December 15. Soon after that date the American Institute of Electrical Engineers will take possession of its commodious new quarters there, and will at once come under heavier responsibilities than it has encountered in the past unless the entire amount necessary is raised to relieve it of the burden of debt.

It is the hope of the officers of the Institute and of the committee that when the building is formally dedicated next April, the Institute may be able then to declare itself free from financial obligation in connection therewith, and it now asks you to join your fellow-members in subscribing to the fund and thus by your generosity aiding in the execution of this splendid enterprise. You are therefore earnestly requested to fill out the accompanying subscription blank so that the committee may include your name in the next list, which it is hoped will be the final one. You will notice that contributions to the fund can be made on the instalment basis, extending over a period of five years.

A general response from the members who have not yet subscribed, each for a modest sum, will give the Institute the $50,000 which it still needs in order that its regular work as a professional body may be carried on with undiminished efficiency and with greater vigor than ever in the new home and with the enlarged facilities.

Awaiting your prompt consideration of this appeal and the return of the subscription blank,

Yours truly,
T. C. MARTIN,
Chairman.

The Land and Building Fund Committee of the Institute is made up as follows:

Institute Committee—T. C. Martin, chairman; J. C. Barclay, John J. Carty, C. L. Edgar, F. W. Jones, J. W. Lieb, Jr., F. J. Sprague, J. G. White.

Advisory Committee—U. N. Bethell, N. F. Brady, Eugene Griffin, Samuel Insull, James H. McGraw, Charles W. Price, Samuel Reber, L. B. Stillwell, Charles A. Terry, Elihu Thomson.

All communications should be addressed to George H. Guy, secretary to the committee, 114 Liberty street, New York city.

Technical Publicity Association.

The Technical Publicity Association held a meeting on Thursday evening, November 22, at the rooms of the Aldine Association, New York city. The report of the circulation committee, consisting of H. M. Davis, of the Sprague Electric Company; C. N. Manfred, of the H. W. Johns-Manville Company, and Paul M. Wade, of the Standard Paint Company, was submitted.

The advertising departments of the following companies were also represented at the meeting: John A. Roebling's Sons Company, American Locomotive Company, Yale & Towne Manufacturing Company, Patterson, Gottfried & Hunter, American Wood Working Machinery Company, General Electric Company, Crocker-Wheeler Company, A. S. Cameron Steam Pump Works, B. F. Sturtevant Company, M. H. Treadwell Company, and the Robins Conveying Belt Company.

The next monthly meeting of the association will probably be devoted to a discussion of catalogues, circulars, etc., and will be held on December 20.

Large Power Scheme for Paris.

It is stated in the *Mechanical Engineer* (London) for November 17 that several members of the Paris (France) municipality and electricians are considering a scheme for utilizing the power of the Rhone river for supplying electric light to the French capital. It is proposed to erect a huge dam across the river at Seyssel, a village near the Swiss frontier. The dam would be over 200 feet high. The entire system would cost $12,000,000. This would be the largest electric power system in Europe, and it is estimated that it would save the city of Paris $5,000,000 a year over what is now the present cost for lighting.

Illuminating Engineering Society.

The monthly meeting of the Illuminating Engineering Society will be held in the Edison Auditorium, 44 West Twenty-seventh street, New York city, on Friday evening, December 14, at eight o'clock. A paper will be presented by Dr. C. P. Steinmetz, the title of which is to be announced later.

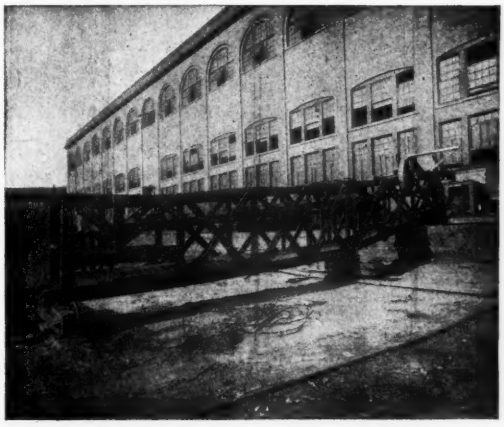
INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

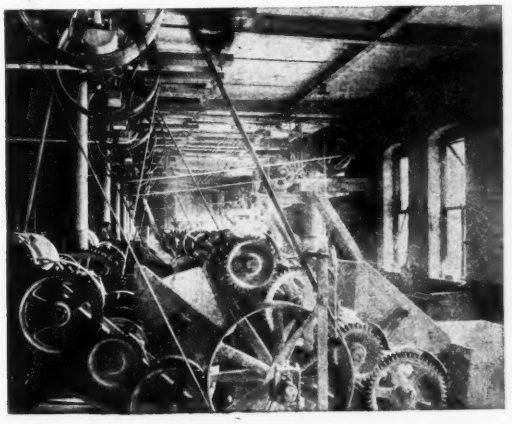
Electric Motor Drive in the Packing Industry.

There is no better example of the versatility of the electric drive for industrial purposes than that afforded in the modern packing house. The comprehensiveness of this industry, including as it does a series of establishments for the manufacture of a wide variety of products, makes the application of the electric drive very apt.

The power house is placed in the most economical location and the power generated is economically transmitted to the various shops and machines without the use of long lines of wasteful shafting. The transmission lines running from the central station switchboard may be so arranged that not only the exact amount of power used in each department may be measured, but the various shops may be run independently. In this way a certain department may work overtime without necessitating the generation of considerable power usually wasted in running idle shafting at such times.



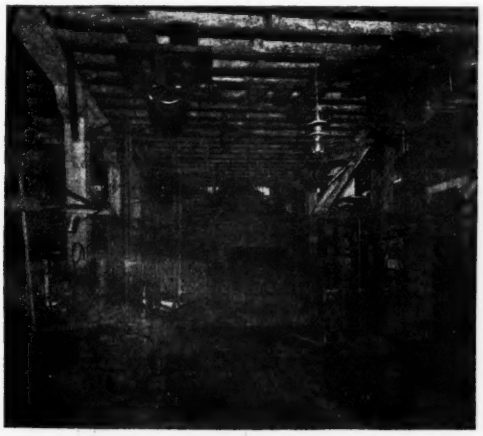
ELECTRICALLY OPERATED COAL CONVEYERS.



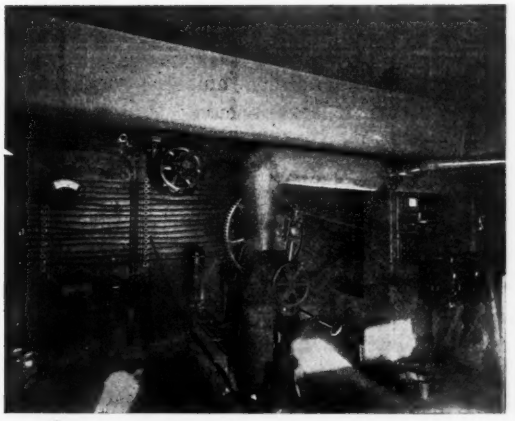
INDUCTION MOTORS DRIVING SOAP MACHINES.

At the receiving end of the transmission line, the advantages of an alternating current induction motor drive are marked. Ease of control, safety and reduced maintenance charges are the most apparent gains. Machines are of various sizes and each has peculiar needs for power. Many products of the packing house are highly inflammable and the detached power house as well as the use of a sparkless induction motor materially reduce the fire-hazard. In some portions of the establishment, particularly hard operating conditions are encountered. Take for example the hog-killing room. Here the steam-saturated air is a particularly severe test for machinery, and the induction motor is the only type capable of handling this class of work continuously.

The plant of Swift & Company, at Chicago, Ill., affords an excellent example of the application of the motor drive. This plant covers a floor space of eighty-seven and three-quarters acres. The different branches of the industry are conducted on the most approved modern lines for the quickest and best conversion of live animals to finished food products, as well as the various by-products. Every hour of the working day 250 head of cattle, 700 hogs and 625 sheep are



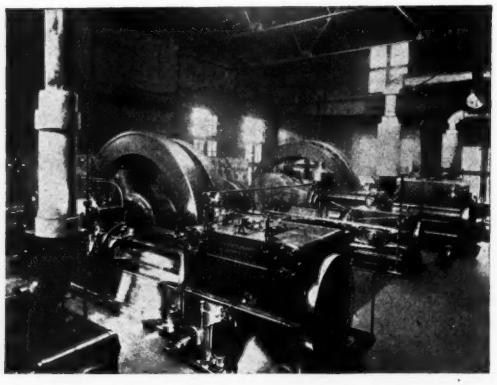
INDUCTION MOTOR IN PRESSROOM.



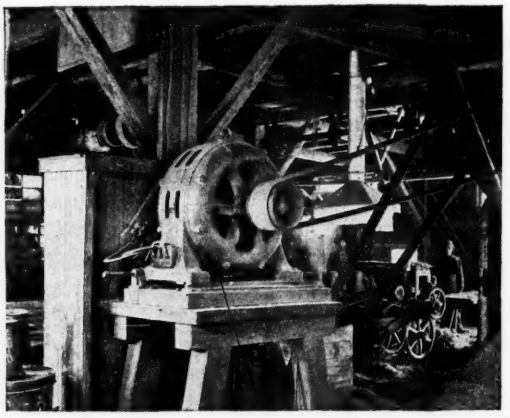
INDUCTION MOTOR-DRIVEN HOUSE PUMP.

slaughtered. The refrigerating plant has a daily capacity equivalent to 2,500 tons of ice.

The packing establishment is operated electrically from a central power station. The boiler house contains 6,400 horse-power in Babcock & Wilcox boilers, delivering steam at 150 pounds pressure to the engines, and equipped with Murphy stokers and the necessary coal and ash handling machinery. Draught for the boilers is obtained by a 265-foot stack.



GENERATING ROOM—POWER-HOUSE.



INDUCTION MOTOR IN PLANING MILL.

In the engine-room there are installed three General Electric three-phase, revolving-field 240-volt, sixty-cycle generators, direct connected to Filer & Stowell cross compound Corliss engines, all operating at 120 revolutions per minute. The generators comprise one 300-kilowatt, one 600-kilowatt and one 1,200-kilowatt machines respectively.

From this central generating station the power is led to the various departments both for motor application and lighting. In all, about 3,600 horse-power in induction motors of the General Electric squirrel-cage armature type are installed. The motors range in size from one to 140 horse-power, the average horse-power per motor being 14.37. Many of the motors are in odd and unusual places, some in coolers at zero temperature, others in dry, dusty rooms at a temperature of over 125 degrees, and many novel and special constructions have necessarily been developed in connection with the motor installation and wiring system. A few synchronous motors are used which tend to help the power-factor. One of these is a 100-kilowatt General Electric machine, driving pumps.

The lighting system is made up of both arc and incandescent lamps, about 12,000 230-volt incandescent lamps and a large number of series alternating-current arc lamps are employed for illumination.

It is interesting to note that the packing establishment was originally operated by several separate plants, with direct-current generators for furnishing light and power. After careful investigation the alternating-current system, with a central power house was installed, and the direct-current system abandoned. Actual experience with both systems was afforded by a previous installation of a smaller multiphase plant in one of Swift & Company's other packing houses. The installation as a whole brings out forcibly the peculiar advantages of the alternating-current motor to this class of service.

Allis-Chalmers Electric Hoists.

The accompanying illustration shows an electric hoist, which is one of a line recently placed on the market by the Allis-Chalmers Company, of Milwaukee, Wis.

The single-drum electric hoists are of fifteen, twenty-five, thirty-five, fifty and seventy-five-horse-power capacity, and double-drum hoists are made by the company in thirty, fifty, seventy-five, 100, 125 and 150-horse-power sizes. The rope speeds and load capacities meet average requirements, and especial attention has been given to insuring reliable, economical and satisfactory operation. Following is a description of the general design and construction details of these machines.

The drum (or drums) and motor are mounted upon a heavy substantial bed-plate of box section, with broad bearing surface on the foundation. The bearings are carried on pedestals cast in one piece with the bed-plate, so that there are no bolts to work loose, and the proper alignment of the machine is thus maintained at all times. The bed-plate and pedestals are of the best quality of cast iron, strong and tough, and of ample proportions to withstand the shocks and strains incident to the heaviest and roughest usage. The bearings of each hoist are all of the same length and diameter, lined with the best quality of babbitt metal. Ample provision is made for thorough lubrication and the bearings are of such size as to make a very low bearing pressure, thus insuring cool running.

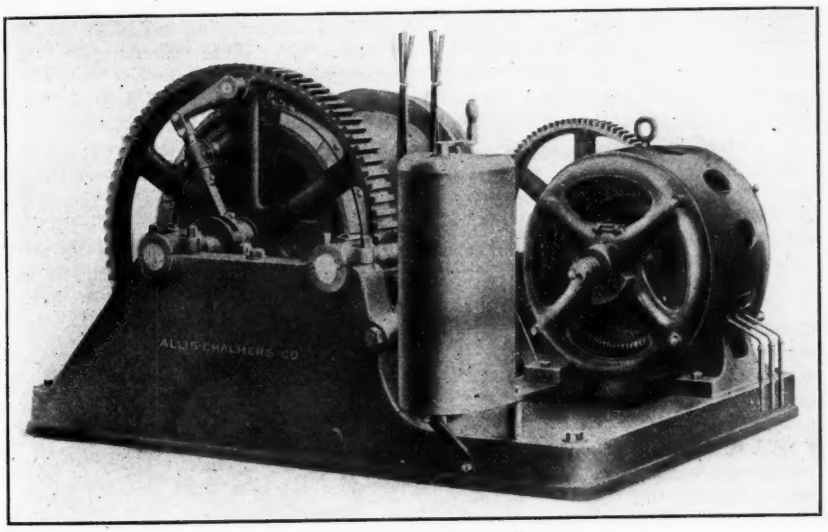
The drum runs loose upon the shaft and is made in one piece, of the best quality of cast iron. The spider hubs are fitted with bronze bushings, which can be readily replaced in case of wear. The drum spiders have strongly ribbed arms, and the drum shell is reenforced by deep circular ribs so that all twisting and bending strains are fully met. The hole in the shell through which the rope passes for fastening has a long radius curve, thus avoiding any sharp bend in the rope and doing away with rope breakage at this point. The face of the drum is straight, and the flanges are of ample depth.

The brake is of the steel band type, with wide face, and is provided with suitable turnbuckle adjustment for taking up the wear on the brake blocks. One end of the brake band is securely anchored by eye-bars around the operating shaft and the other end has a turnbuckle attachment to the lever on the operating shaft controlled by the operator's hand lever.

The main gear, keyed on the drum shaft, forms the driving member of the clutch, which is of the band friction type. The fixed end of the band is securely anchored to the driving gear and has suitable adjustment for shortening the band to compensate for wear. The movable end of the band is actuated by a simple and strong

arrangement of toggle lever, motion to which is imparted by a collar sliding on the drum shaft and controlled by the operator's hand lever through suitable connections. When the clutch is thrown in, the band is tightened around the drum shell by the powerful toggle motion, and the pull of the rope on the drum tends to still further tighten the grip of the band on the shell, thus securely holding and lifting the load. Both band friction clutch and band brake are hand operated, the operating levers being conveniently arranged, and provided with quadrants and locking pawls.

Both drum and intermediate shafts are of best quality of open-hearth steel, accurately turned and keyseated to receive the gears. They are made extra large in diameter and are calculated to withstand the most severe usage.



ALLIS-CHALMERS ELECTRIC HOIST.

The gears are cast of a special mixture of the best quality of tough, strong iron with heavy rims, arms and hubs. The pinions are of cast steel. The teeth of both wheels and pinions are cut. The accuracy of the workmanship and the low rim speed of the gears insures their quiet running and long life. When desired, the pinion on motor shaft will be made of rawhide at a small additional cost.

For driving these hoists the company furnishes either direct or alternating-current motors wound for the usual voltages, and if alternating current, either twenty-five-cycle or fifty-cycle machines.

The controllers used with these hoists are of the drum type, similar to those in common use in street-car service. On all single-drum hoists the motor is not reversed, but on double-drum hoists the handle or lever of the controller not only controls the speed but also reverses the motor, and is locked in the "off" position. The controller is securely attached to the frame of the hoist, and the lever is so located as to be conveniently reached and easily handled by the operator. If desired the lever of the controller can be made of the same design as the brake and clutch levers.

BOOK REVIEWS.

"Practical Lettering." Thomas F. Meinhardt. New York. The Norman W. Henley Publishing Company. Paper. 16 pages. 9 by 14 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at 60 cents.

This is intended to be a guide for draughtsmen, engineers and others having occasion to letter. It analyzes the various letters and gives an original system for spacing. Charts of letters are given, as well as hints for pen work and for duplication.

"Manual of Wireless Telegraphy." A. Frederick Collins. New York. John Wiley & Sons. Cloth. 232 pages. 5 by 7½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $1.50.

This work is put forward as a manual containing detailed and explicit instructions for setting up various types of apparatus used in wireless telegraphy, for adjusting the circuits, and for testing. Diagrams are given of the various systems.

"Fowler's Electrical Engineer's Handbook." Manchester, England. Scientific Publishing Company. Leatherette. 730 pages. 4 by 6 inches. Illustrated. Price, 2*s.* 6*d.*; superior binding, gold edges, 3*s.* 6*d.*

The new edition of this well-known handbook contains about 100 pages of additional matter, which includes information regarding electric meters, long flame arc lamps, cable testing, resistance wires, etc. The volume contains as usual a large amount of useful engineering data, and, in addition, a directory of British power systems.

"Dynamoelectric Machinery." Vol. ii. Seventh edition. S. P. Thompson. New York. Spon & Chamberlain. Cloth. 848 pages. 6 by 9 inches. Illustrated and containing 24 plates. Supplied by the ELECTRICAL REVIEW at $7.50.

In this new edition of Dr. Thompson's well-known textbook an effort is made to bring the matter up to date so as to include all changes that have been made during the nine years that have elapsed since the sixth edition. The volume has been practically rewritten and less than 100 pages have been taken from the former edition. A good deal of new matter is added, including a chapter on periodic functions, which gives a new and simplified method of harmonic analysis. Much prominence is given to methods of design, especial attention being paid to the developments necessitated by the introduction of the steam turbine. The book concludes with a chapter on the single-phase commutator motor, which has, of late, been the subject of so much discussion. The subjects are treated in the author's well-known clear and logical manner.

"The Design of Steel Mill Buildings and the Calculation of Stresses in Framed Structures." Second edition, enlarged. Milo S. Ketchum. New York. The Engineering News Publishing Company. Cloth. 480 pages. 6½ by 9 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $4.

This book is intended to provide a short course in the calculation of stresses in framed structures and to give a brief discussion of mill building construction. It is to supplement elementary books on stresses, on the one hand, and the more elaborate treatises on bridge design on the other. A great deal of the matter contained in it is applicable to all classes of steel frame construction. Part i discusses the various kinds of loads to be provided for; Part ii the stresses in the structure, and Part iii takes up the design of buildings. There are two appendices, one giving specifications for steel frame mill buildings, and one problems in graphic statics. There are also a number of useful tables showing the dimensions of structural iron. The author has evidently made a special study of the subject and his teaching experience enables him to present it excellently. The book is well adapted for students of building construction and should be equally useful as a work of reference for structural engineers.

Current Electrical News

DOMESTIC AND EXPORT.

INDIANA TRACTION MERGER—Plans for the organization of a holding company to include the eight interurban traction lines known as the Indiana Union Traction, Indianapolis & Western, Indianapolis & Northwestern, Indianapolis & Eastern, Indianapolis & Martinsville, Indianapolis Coal Traction, Wayne & Wabash Valley and the Richmond Street and Interurban are about to be perfected. This merger will result in the largest or the second largest traction system in the world.

TO ELECTRIFY PENNSYLVANIA RAILROAD—According to a statement by an official of the Pennsylvania Railroad, cars will soon be run by electricity over the Pennsylvania Railroad between Philadelphia and Pittsburg, Pa. According to this statement, work will soon be started on a power plant and dam at Iroquois, about twenty miles west of Harrisburg, to furnish power to supply the telegraph and signal towers and to run cars between Aqueduct and Mifflin. Hundreds of acres of land have been purchased by the railroad at Iroquois, much of it along the river front.

NEW OHIO ELECTRIC ROAD—The Cleveland & Sharon Traction Company has been incorporated with a capital of $2,500,000. This is the organization financially of a four-year-old project, and, it is said, is headed by interests with which Francis Morgan is identified, although his name does not appear in the incorporation papers. The incorporators as filed are: E. Jay Pinney, C. W. Dille, H. Nord, D. C. Pinkey and C. M. Pierce. Several routes for the proposed road have been laid out. One goes through Chagrin Falls and another *via* Solon and Geauga Lake. As yet no contracts for work have been let.

INCORPORATION OF CALIFORNIAN PUBLIC SERVICE COMPANY—The Pacific Coast Development and Securities Company has been incorporated with a capital of $1,000,000 at San Diego, Cal. It is stated that English capital is interested in the enterprise. The Californians who control the subscribed stock are: John Campbell, Arthur Small, Frank Turnbull and John K. Durrill. Mr. Small states that the company's operations will include the erection of plants to supply gas and electric lights and power to places where these utilities have not thus far been developed, but that the main work to be undertaken will be the construction and operation of transportation lines of an interurban character.

ELECTRIC CONCERNS TO MERGE—Official announcement of the proposition of the Electric Bond and Share Company, of New York city, to take over the Electric Company of America, of Philadelphia, Pa., has been made. The proposition provides for an exchange of the present stock of the Electric Company of America into a collateral trust five per cent gold bond equivalent to a value of $14 per share, to be secured by a pledge of the securities turned in by the Electric Company of America. The bonds will also be secured in the sum of $1,000,000, which will be paid to a trustee and constitute a fund which can be used only for betterments and extensions to the Electric Company of America properties. The exchange will work out equivalent to a dividend of seven per cent of the par value of the present Electric Company of America stock.

TRANSIT LINES UNITE—The Hoboken & Manhattan Railroad Company and the Hudson & Manhattan Railway Company have filed articles of consolidation under the name of the Hoboken & Manhattan Company, with a capital stock of $38,500,000. Of this amount $15,000,000 will be preferred, bearing six per cent cumulative dividends. In consolidating, the companies provided for an increase of $6,400,000 in addition to the combined authorized stock of the two concerns. Recently both the Hudson and Hoboken companies increased their capital stocks to carry on the boring of the tunnels under the Hudson river. At that time the Hoboken company increased its stock from $500,000 to $15,000,000 and the Hudson concern from $100,000 to $17,100,000. The officers of the new company are: president, Alexis P. Bartlett, New York; vice-president, Edward R. Greene, Brooklyn; secretary, Ross A. Mackey, Brooklyn, and treasurer, Neil A. Weathers, New York.

HUDSON RIVER WATER POWER COMPANY—Judge Ray in the United States District Court at Utica, N. Y., on November 26, made a decision in the matter of the application to have the Hudson River Water Power Company declared a bankrupt. The Court refuses to dismiss the proceedings pending the settlement of some legal questions by the Appellate Division. About one year and a half ago the National Contracting Company, of New York, which alleged that it had a claim for nearly $500,000 against the power company, with two other creditors for nominal amounts, filed a petition in the United States District Court, following the appointment of a receiver in the state courts, asking that a receiver be appointed and the company declared a bankrupt. The litigation which followed, it was generally understood, disclosed that some sort of a settlement was under way. Judge Ray in a long opinion denied the application to dismiss the proceedings, "with leave to renew on some papers and additional proceedings in the case when the Appellate Division has passed upon the questions involved."

NEW YORK CITY TERMINAL OF HUDSON RIVER TUNNELS—Details have been made public in regard to the terminal buildings in New York city for the New York & New Jersey Railroad and the Hudson & Manhattan Railroad Company. There will be two buildings in Church street, from Cortlandt to Dey streets, and from Dey to Fulton streets, Manhattan. The northerly building will be known as the Fulton Building, and the southerly as the Cortlandt. They will each be twenty-two stories above the surface, and will extend seventy-five feet below the street line to bedrock. There will be space for 4,000 offices, and when completed, it is said, will constitute the largest office structure in the world. Beneath these buildings will be the terminal station of the Hudson & Manhattan Railroad Company, which will operate the tunnels now being built under the Hudson river. Passengers will enter upon the street floor and pass down into the station by means of easy stairways, inclined planes and elevators. The first floor below the sidewalk will be known as the concourse. Here will be the waiting rooms and ticket booths. Below this will be the train platforms. There will be five tracks running between six platforms. The cars will be of steel and capable of seating fifty persons each. The passage under the river, it is calculated, will average three minutes, so that a resident of Jersey City should be able to reach the heart of the Manhattan shopping district in from ten to fifteen minutes. Of the four trolley tunnels now being built under the North river, the two down-town are about three-fifths completed, and the up-town completed to Sixth avenue, Manhattan. It is estimated that the entire outlay of money in the tunnel enterprises projected by the companies will reach $60,000,000. The Church street terminal buildings will cost about $8,000,000.

NEW PUBLICATIONS.

CENSUS OF MANUFACTURES, 1905—The Department of Commerce and Labor, Bureau of the Census, Washington, D. C., has issued bulletin No. 57, composing the census of manufactures, 1905, for the United States. The census is to be taken every fifth year, and the next enumeration will cover the year 1909.

THE ANNUAL REPORT OF THE WATER AND LIGHT DEPARTMENTS OF DANVILLE, VA.—The annual report of the water and light departments of Danville, Va., for the fiscal year 1905-1906 has been published. This includes a description of the new pumping station, the bacteriological report on the mechanical filtration plant, the balance sheet and statements concerning the physical operation of the plants.

PERSONAL MENTION.

MR. ALFRED T. SCOREY has resigned as electrical superintendent of the Lowell (Mass.) Electric Light Corporation.

MR. C. H. JOHNSON, vice-president of the Curtis Advertising Company, Detroit, Mich., was a visitor to Chicago last week.

MR. L. P. SAWYER, manager of the Buckeye Electric Company, Cleveland, Ohio, was a Chicago visitor from Saturday, November 24, to Monday evening, November 26.

MR. JOHN DALE, president of the Dale Company, a large fixture manufacturing house of New York, recently returned from a six-months' trip around the world.

MR. SYDNEY IRVING WAILES, manager of sales of the National Brake and Electric Company, Milwaukee, Wis., was married on Tuesday, November 27, to Miss Adelaide Harrington Brown, at St. John's Church, Los Angeles, Cal. Congratulations and best wishes to Mr. and Mrs. Wailes.

MR. JOHN H. MILLER, of San Francisco, Cal., and Timothy D. Merwin, heretofore a member of the firm of Boardman, Platt & Soley, of New York city, have formed a partnership under the firm name of Miller & Merwin for the practice of patent law, with offices at 35 Wall street, New York city, and 553 Van Ness avenue, San Francisco, Cal.

MR. WILLIAM H. BROWNE has resigned as director, treasurer and general manager of the Stanley Instrument Company, Great Barrington, Mass. Mr. Browne has been connected with the Stanley company since January, 1902. For some time the business of the company has been shut down by injunction obtained in patent litigation by the Westinghouse Electric and Manufacturing Company, and on June 1 its manufacturing plant and property were sold to the General Electric Company. Mr. Browne continued his official relations with the company until last month, when he resigned in order to be free to seek opportunity for the varied and extensive experience he has had since 1886 in the electric light, power, traction and manufacturing business. In 1886 Mr. Browne was interested in the organization and building of the electric railroad and lighting plants at Richmond, Va., and was associated with these interests until 1889. From May, 1888, to July, 1894, he was general manager of the United Electric Light and Power Company, of New York city. From July, 1894, to January, 1895, he was receiver of the Flushing & College Point Railroad, Flushing, Long Island. From January, 1895, to January, 1902, he was general manager of the Royal Electric Company, Montreal, Canada. From January, 1902, to November, 1906, he was with the Stanley Instrument Company. Mr. Browne has not made any definite arrangements at the present time, but expects to undertake the supervisory administration and management of several plants. His headquarters at present are at 34 Pine street, New York city.

ELECTRICAL SECURITIES.

The holiday was in some measure responsible for the small amount of trading done in the stock market last week. There has been no change in the public attitude either from a speculative or investment viewpoint, and while there has been a great apathy with regard to public buying, there has also been evident a similar condition of mind with regard to public selling. The expected monetary tightening over the heavy December payments forced call rates up to 27 per cent. It is held in some quarters that conditions to-day are so similar to those of a year ago that a repetition of last December's increasing money tension will be witnessed. These same interests predict that the 125 per cent call money rate made previous to the beginning of last year may even be surpassed. The presidential message will be studied with keen interest in all sections of the country, as it is expected that it will be in line with congressional action during the year, and until the message has had careful scrutiny and the effect of its expressions has been discounted, very little advancement may be expected in stock-market conditions.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 1.

New York:	*Closing.*
Allis-Chalmers common	17⅛
Allis-Chalmers preferred	45½
Brooklyn Rapid Transit	80⅜
Consolidated Gas	137
General Electric	177
Interborough-Metropolitan common	37
Interborough-Metropolitan preferred	76⅝
Kings County Electric	150
Mackay Companies (Postal Telegraph and Cables) common	73
Mackay Companies (Postal Telegraph and Cables) preferred	69
Manhattan Elevated	143¼
Metropolitan Street Railway	106
New York & New Jersey Telephone	126
Western Union	87¼
Westinghouse Manufacturing Company	151

Directors of the General Electric Company have decided to offer $10,861,200 new stock, equal to 20 per cent of present holdings, at par to stockholders of record December 8. The issue represents in part stock that has long been in the treasury and part of the recently authorized $20,000,000.

J. & W. Seligman & Company and Redmond & Company, with associates, secured 38,000 shares of the total of 48,000 shares of the Manhattan Railway Company, sold at auction on November 28, paying an average price of 141¼. It is announced that a large amount of the stock purchased has already been placed. Through the sale at public auction of the 48,000 shares of the Manhattan Railway Company stock, the Interborough Rapid Transit Company will receive a total of $6,776,643. The indebtedness of the Manhattan to the Interborough on September 30 last for direct advances amounted to $3,452,183. Consequently, this indebtedness will be wiped out and a balance of $3,324,460 left to the Interborough, which will be used for additional improvements and equipment in connection with the Manhattan system. The annual fixed charges of the Interborough will be increased $336,000 per annum as a result of the issue, as dividends of 7 per cent will have to be paid on the stock the same as on that already outstanding. The outstanding stock of the Manhattan now amounts to $60,000,000, which is the total amount authorized, and dividends of $4,200,000 must now be paid on this issue.

Stockholders of the Western Union Telegraph Company have been notified by circular of their privilege to subscribe between December 6 and December 17, both dates inclusive, for the convertible 4 per cent redeemable bonds, authorized recently, equal to 10 per cent of their respective holdings of the stock of the company of record December 5. The bonds will be convertible at the option of the holder into the stock of the company at par at any time after January 2, 1909, and before January 2, 1919. The bonds will be redeemable at the option of the company, at 5 per cent premium and accrued interest on May 1, 1912, or any interest day thereafter, on notice of call. The price fixed by the board of directors for the bond is $875 for a bond of $1,000 face value.

Boston:	*Closing.*
American Telephone and Telegraph	137
Edison Electric Illuminating	225
Massachusetts Electric	70
New England Telephone	129
Western Telephone and Telegraph preferred	79
Philadelphia:	*Closing.*
Electric Company of America	11¾
Electric Storage Battery common	69
Electric Storage Battery preferred	69
Philadelphia Electric	8¼
Philadelphia Rapid Transit	21¾
United Gas Improvement	97
Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	141
Metropolitan Elevated preferred	70⅛
National Carbon common	85½
National Carbon preferred	115
Union Traction common	—
Union Traction preferred	—

The Metropolitan Elevated November daily average was 152,471 passengers, an increase of 24,195.

The daily average of passengers carried by the South Side Elevated during November was 94,281, an increase of 2,125 over the figures for 1905.

ELECTRIC LIGHTING.

ESSEX, IOWA—Oscar Nelson has been granted a franchise for a light and power system.

NIAGARA FALLS, ONTARIO—The city has disposed of $20,785 of light bonds to the firm of Wood, Gundy & Company, Toronto.

CLINTON, MO.—Work on Clinton's municipal electric light plant has been started. It is thought that the plant will be in operation by the middle of January.

BRONTE, TEX.—An electric lighting company has been organized at Bronte, and it is expected to have the plant in operation by Christmas. Frank Hickman is president of the company and Robert Knierim general manager.

DELHI, N. Y.—A new lighting company has been formed in Edmeston. The building and equipment of the old company has been bought and will be moved to a site near the Wharton creek. C. T. Coats, V. D. Robinson, R. C. Huestis and Bert Gilson compose the new company.

LAPEER, MICH.—Outside parties have been induced to help finance the Schlegel electric power plant and Mr. Schlegel states that it will supply the city with power by January 1. Already the poles have been set within a half-mile of the city. The plant itself is two and one-half miles out. Machinery has been shipped for the completion of the plant.

DENVER, COL.—Another $400,000 is about to be expended in Nevada electric power schemes by the Nevada Power, Mining and Milling Company, of which concern Lawrence C. Phipps and other Denver capitalists are directors. Preparations are being made to extend the power lines of the company to the Bullfrog mining district, a distance of ninety miles from the present lines.

WELLAND, ONTARIO.—The Welland town council has given the contract for street lighting to the Stark Electric System, Limited, of Toronto. The contract is for forty arc lights of 2,000 candlepower, each of the most improved style, and the price is to be $40 per light per year, all public buildings belonging to the corporation to be lighted free. The rate for private lighting is to be eight cents per kilowatt-hour, with twenty-five per cent discount if paid by the fifteenth of the month.

ELIZABETH, PA.—The Elizabeth Electric Light, Heat and Power Company has changed hands and will be under new management. The new owner is the West Penn Electric Company, which operates the trolley lines which cover the coke-region towns and also the electric light systems in all of these towns. To the list have recently been added all the towns in the Monongahela valley from Monongahela to Brownsville. The central power station of the company is located at New Haven, across the river from Connellsville. For the present the works at Elizabeth will be operated independently.

BATAVIA, N. Y.—Franchises have been granted to the Niagara & Lockport Power Company and to the Genesee County Electric Light, Power and Gas Company by the town board and highway commissioners. There was a little discussion regarding the matter, as copies of the proposed grants had been carefully examined by the town officers in advance. The franchises give the companies the privilege of distributing electricity in Batavia and contain provisions calculated to protect the town's interests. The town gets nothing for the franchises. For lamps twelve cents per kilowatt-hour, with a discount of two cents if the bill is paid in a specified time, will be charged, except that no bill shall be rendered for less than $1.

MIDDLEVILLE, N. Y.—The Middleville Electric Light Company has been granted consent by the commission of gas and electricity to increase its capital stock from $4,000 to $12,000, the increase to be used for the purpose of the further development of the plant, installation of a new power-house and canal, etc. New generating equipment is to be installed and many improvements made. The capacity is now fifty horse-power and when the changes are made the capacity will be increased to 120 horse-power. The company furnishes light only at present, but will be able to supply power when the improvements are completed. The power comes from the West Canada creek. David E. Ford is the president and general manager of the company, Lewis H. Goodman the secretary and treasurer and A. M. Goodman the vice-president.

ELECTRIC RAILWAYS.

EASTLAND, TENN.—The Nashville, Chattanooga & St. Louis Railway Company will, it is stated, build a line from Eastland to Dunlap.

SENECA FALLS, N. Y.—The scheme for connecting the village of Seneca Falls with the city of Ithaca by an electric railroad has been again revived.

PITTSBURG, PA.—Charles Gibson, manager of the Pittsburg & Butler Railway Company, announces that the first cars will be operated between Butler and Pittsburg about December 28.

DETROIT, MICH.—The Detroit Trust Company has taken charge of the Detroit, Saginaw & Flint Electric Company, which has bonds amounting to $410,000, interest on which was defaulted. The bonds are held principally in Detroit. Thirteen miles of the proposed line have been built and are in operation. The company will be reorganized.

GETTYSBURG, PA.—The Pennsylvania Railroad and the Cumberland Railroad, backing the Valley Traction Company, operating lines in Cumberland valley, have purchased forty miles of turnpike from Chambersburg to Littlestown *via* Gettysburg. The consideration was around the $50,000 mark. Work will begin at once to extend trolley lines over this road.

DAVENPORT, IOWA—Announcement is made of the formation of the Tri-City Railway and Light Company to take over the light and traction interests of Davenport. At present these interests are held by eight companies, and it is planned to reduce these to three, these three in turn to be controlled by one corporation. The new company proposes to make certain reductions in traction fares.

RIVERSIDE, CAL.—The franchise for an electric railroad which will connect Riverside with Colton has been awarded by the city trustees to A. C. Denman, Jr., president and general manager of the San Bernardino Valley Traction Company. This road will give Riverside direct trolley communication with San Bernardino and Redlands and will be an important link in the chain of southern California interurban electric lines.

PITTSBURG, PA.—Division Superintendent B. W. Duer, of the Baltimore & Ohio, has recommended to the higher officers of the road that the branch of the Buffalo, Bradford & Kane road, from Kane to Mt. Jewett, which the Baltimore & Ohio operates as part of its narrow-gauge branch from Foxburg to Mt. Jewett, be standardized and operated by electricity. This proposition may also eventually be extended to the Foxburg-Kane narrow-gauge line.

ALBANY, N. Y.—A certificate of merger of the Olean Street Railway Company and the Rock City Railroad Company, forming the Olean Street Railway Company, has been filed with the secretary of state. The capital stock is $1,400,000, and the directors are: James F. Johnson, M. L. Lee, Thomas Gilligan, I. W. Meller and W. P. Page, of Olean; W. B. Merserfen, of Portville; Clare Willard and Edward Torrey, of Allegany, and Julius C. Calisch, of Buffalo.

SPRINGFIELD, OHIO—A corps of engineers is already at work surveying for the new interurban line which is to be built by the Springfield, Wilmington & Cincinnati Railway Company, incorporated by George F. Parmalee and others. This is known as the Frey line, and will run from Springfield to Clifton, Cedarville, Jamestown, Wilmington and Cincinnati, with a branch to Xenia. It is considered the best traction proposition in this section, and is not touched by any other interurban or steam road. Eldenbel & Company, of New York, will construct the line.

BALTIMORE, MD.—Nearly fifty per cent of the work on the Baltimore and Washington electric car line has been completed, and officials of the Baltimore, Washington & Annapolis Electric Railway Company say the cars will be in operation between the two cities next summer. The entire line to Washington will be only thirty-three miles long, or more than seven miles shorter than the routes followed by the steam roads. The line will pass through an undeveloped territory. It will connect with the trolley road now in operation from Laurel to Washington, which it owns, but this will not form a part of its line, as might be supposed. The cars to be operated on the line will be capable of attaining a speed of forty-five miles an hour, and, while no announcement has yet been made, will probably be run on a fifteen-minute schedule. There will be express and local trains, and freight as well as passenger service will be provided.

TELEPHONE AND TELEGRAPH.

WHEELING, W. VA.—John A. Howard has secured entire control of the National Telephone Company, paying about $100,000 for the allied Schmulbach interests.

PROVIDENCE, R. I.—The state capitol has been equipped with a complete telephone system. The new board has 100 pairs of wires, although only sixty will be in service at the start.

MILWAUKEE, WIS.—The Milwaukee city council has passed by a vote of forty-five to one a franchise allowing the Wisconsin Independent Telephone Company to do business in the Wisconsin commercial centre.

GLENWOOD, MINN.—The Glenwood Telephone Company has sold its exchange, consisting of 225 local and thirty rural subscribers, to the Minnesota Central Telephone Company, which will rebuild the same.

MARLBOROUGH, CT.—The Southern New England Telephone Company will extend its line from Marlborough Centre to Marlborough Mills, and discontinue the old line running from the mills to the East Hampton line.

STEUBENVILLE, W. VA.—The National Telephone Company will establish a branch exchange in Steubenville, at an approximate cost of $80,000. The company expects, within the next year, to have 2,000 subscribers in the city.

WATERBURY, CT.—Manager J. D. Veitch, of the Waterbury division of the Southern New England Telephone Company, announces that there has been an increase of about 500 telephones in his division since the first of this year.

APPLETON, MINN.—The Minnesota Central Telephone Company has recently reconstructed its exchange at Appleton, replacing overhead wires with cable distribution. One hundred new rural subscribers in adjoining townships are being connected.

WOODBURY, CT.—The Waterbury Automatic Telephone Company will place all the telephone wires running north in a cable. New poles will be set to carry the cable. The capital stock of the company has been increased from $15,000 to $22,500.

CUMBERLAND, MD.—The Burlington Telephone Company, of West Virginia, has purchased the Chesapeake & Potomac Telephone Company, operating in the vicinity of Cumberland, Md. The former company now controls the territory east and south of Keyser, W. Va., and will build to Norfolk and Richmond, Va.

CHARLOTTE, N. C.—The corporation commission of North Carolina has sent out notices to all the telephone companies in the state to the effect that it has under consideration the question of fixing rates for charges for messenger service and rental of telephones by the various telephone companies in the state, and directing the various companies to forward, for file in the office of the commission and for their consideration, the schedule of rates now charged.

CHICAGO, ILL.—It is stated that access to Chicago will be given the Tri-State Telephone and Telegraph Company, of Minneapolis, by the Automatic Company, of that city. Some time ago E. H. Moulton, president of the Twin City and toll independent line, announced that he might build to Chicago. He now states that his company will enter Chicago over the Automatic Company's wires. The Automatic people will build lines to distances ranging from thirty to sixty miles out of the city to meet the independent leads.

NEW MANUFACTURING COMPANIES.

COLUMBUS, OHIO—The Engler Electrical Manufacturing Company has been incorporated with a capital of $5,000 by John J. Angel, H. P. Engel, E. H. Blum, George Scott and H. D. Champlin.

ALBANY, N. Y.—The Bayley-Lee Electric Company, of Brooklyn, has been incorporated to manufacture and sell light, heat and power-generating machinery. The capital stock is $15,000, and the directors are George W. Bayley, George H. Bayley and William H. Heim, of Brooklyn.

INDUSTRIAL ITEMS.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., is distributing circular No. 1139, describing and illustrating starting and field rheostats.

THE FRENCH BATTERY COMPANY, Madison, Wis., has ready for distribution a new catalogue descriptive of its "Fleur de Lis" dry batteries and electric novelties. This catalogue will be sent to any one interested upon request.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., is about to issue a new bulletin descriptive of its direct-current, engine-type generators designed for general lighting and power work in connection with steam, gas or oil engines.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has published bulletin No. 4465, devoted to trolley frogs, their proper selection and location for different services; and bulletin No. 4467, devoted to the emergency straight air-brake system.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., in bulletin No. 26 describes and illustrates its electric interlocking system. In bulletin No. 28 the Westinghouse automatic electro-pneumatic block signals on the electrified division of the West Jersey & Seashore Railroad are described.

THE INDUSTRIAL MOTOR COMPANY, 1310 G street, N. W., Washington, D. C., has published a catalogue illustrating and describing its telpher system adapted to overland transportation of mail, express, freight and passenger service, and loading and unloading vessels at sea away from wharf facilities.

THE BRILLIANT ELECTRIC COMPANY, Cleveland, Ohio, it is understood, is contemplating enlarging its plant. Notwithstanding the fact that this company has one of the best-equipped lamp factories in the country, so great has been the demand for Brilliant incandescents that the company, so rumor has it, is looking up a new site for the erection of a larger plant, equipped with every modern facility.

THE LOMBARD-REPLOGLE ENGINEERING COMPANY, Akron, Ohio, is calling attention to a letter received from the Montreal Cotton Company, Valleyfield, province of Quebec, testifying to the efficiency of a type L.R.-18 governor controlling two sixty-inch Smith-McCormick turbines operating under twelve-foot head and driving a three-phase alternating-current generator.

THE BENJAMIN ELECTRIC MANUFACTURING COMPANY, Chicago, Ill., has published a handsome catalogue descriptive of wireless clusters and lighting specialties. In addition to the descriptive matter and price list there are scores of engravings showing various forms of clusters and other illuminating standards. This catalogue is very interesting and forms a worthy addition to the trade literature of this character.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has published an attractive booklet entitled "Air-Compressor Lubrication." This calls attention to a number of statements which have appeared in several technical journals concerning the lubrication of air-compressor cylinders. The utility of graphite for this purpose is pointed out, and some interesting conclusions drawn with regard to the use of graphite for lubrication in general.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., is distributing two attractive folders entitled, respectively, "The Question of Operators" and "Now On To Chicago." The first deals with the utility of the Automatic telephone because of its freedom from operator's troubles. The second contains a reproduction of several newspaper clippings concerning the reorganization of the South Bend (Ind.) Home Telephone Company. This company is to be equipped with Automatic telephones, and efforts will be made to have direct toll service with Chicago, Indianapolis, Grand Rapids and several Ohio cities.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, announces that the Boston (Mass.) branch will move early in December to a new building at Nos. 55-59 High street, Boston. The entire building, which comprises seven floors, will be occupied by the offices, sales and shipping rooms of the company. Every facility will be provided for doing business comfortably, con-

veniently and promptly. The increased space will enable the company to carry a much larger stock on hand than ever before.

THE NATIONAL BRAKE AND ELECTRIC COMPANY, Milwaukee, Wis., reports among recent orders for generators the following: Simmons Manufacturing Company, Kenosha, Wis., one 1,000-kilowatt engine-type alternator; Union Electric Light and Power Company, St. Louis, Mo., two 500-kilowatt three-unit synchronous motor-generator sets, and one 200-kilowatt induction motor-generator set; Proctor & Gamble (for Staten Island plant), one 400-kilowatt engine-type alternator, and one 125-kilowatt engine-type alternator; Hicks Locomotive and Car Works, Chicago, Ill., one 500-kilowatt belted alternator; Clymer Power Company, Riegelsville, Pa., one 250-kilowatt water-wheel type alternator; United States Light and Traction Company, Hobart, Okla., one 250-kilowatt engine-type alternator, and one 250-kilowatt engine-type alternator for the company's Sheridan (Wyo.) plant.

Directory of Electrical and Allied Engineering and Scientific Societies.

(Published in the Second Issue of Each Month.)

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Secretary, L. O. Howard, Cosmos Club, Washington, D. C.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. C. E. Skinner, New Haven, Ct.

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, S. S. Sadtler, 59 South Tenth street, Philadelphia.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, 95 Liberty street, New York. Meetings, fourth Friday of each month.

AMERICAN MATHEMATICAL SOCIETY. Secretary, F. N. Cole, 59 West 116th street, New York city.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Secretary, J. W. Taylor, Old Colony Building, Chicago, Ill.

AMERICAN ROENTGEN RAY SOCIETY. Secretary, Dr. G. C. Johnston, 514 Bijou Building, Pittsburg, Pa.

AMERICAN SOCIETY FOR TESTING MATERIALS. Secretary, Professor Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Secretary, Calvin W. Rice, 12 West Thirty-first street, New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Secretary, G. W. Tillson, Municipal Building, Brooklyn, N. Y.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION. Secretary, B. V. Swenson, 60 Wall street, New York.

AMERICAN STREET AND INTERURBAN RAILWAY ENGINEERING ASSOCIATION. Secretary, S. W. Mower, London, Canada.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, Ernest H. Davis, Williamsport, Pa.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, Milwaukee, Wis. Annual meeting, Atlantic City, N. J., June 19, 1907.

ASSOCIATION OF ELECTRIC LIGHTING ENGINEERS OF NEW ENGLAND. Secretary, Welles E. Holmes, 308 Washington street, Newton, Mass. Annual meetings held in Boston on third Wednesday in March.

CALIFORNIA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, P. T. Whittier, Spencer, Cal.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, T. S. Young, Toronto, Ontario.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION. Secretary, J. F. Dostal, Denver, Col.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Secretary, E. W. Poole, Bridgeport, Ct.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, J. I. Lyle, 39 Cortlandt street, New York.

ELECTRIC CLUB OF CLEVELAND. Secretary, George L. Crosby, 1200 Schofield Building, Cleveland, Ohio.

ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, John P. Faure, 77 Water street, Ossining, N. Y.

ELECTRICAL CONTRACTORS' ASSOCIATION OF STATE OF MISSOURI. Secretary, Charles J. Sutter, 1220 Pine street, St. Louis, Mo.

ELECTRICAL SALESMEN'S ASSOCIATION. Secretary-Treasurer. George H. Erich, 401 Monadnock Block, Chicago. Next annual meeting, Chicago, January, 1907.

ELECTRICAL TRADES ASSOCIATION OF CHICAGO. Secretary, Frederic P. Vose, Marquette Building, Chicago.

ELECTRICAL TRADES ASSOCIATION OF PHILADELPHIA. Secretary, E. A. Symmes, 810 Drexel Building, Philadelphia, Pa. Meetings, second and fourth Thursdays each month.

ELECTRICAL TRADES ASSOCIATION OF CANADA. Secretary, William R. Stavely, Royal Insurance Building, Montreal, Canada. Next annual meeting, January 14, 1907.

ELECTRICAL TRADES ASSOCIATION OF THE PACIFIC COAST. Secretary, Albert H. Elliott, Claus Spreckles Building, San Francisco, Cal. Monthly meetings, San Francisco, first Thursday of each month.

ELECTRICAL TRADES SOCIETY OF NEW YORK (Member National Electrical Trades Association). Secretary, Franz Neilson, 80 Wall street, New York. Board of Directors meets second Friday of each month.

EMPIRE STATE GAS AND ELECTRICAL ASSOCIATION. Secretary, Rolland A. Davidson, 58 William street, New York city, N. Y.

ILLINOIS STATE ELECTRICAL ASSOCIATION. Secretary, H. E. Chubbuck, La Salle, Ill.

ILLUMINATING ENGINEERING SOCIETY. Secretary, Dr. Arthur H. Elliot, 4 Irving place, New York. Meetings in New York, second Friday of each month.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA. Secretary, E. W. Landgrebe, Huntingburg, Ind.

INDIANA ELECTRIC RAILWAY ASSOCIATION. Secretary, P. H. White, Indianapolis, Ind. Monthly meetings, second Tuesday of each month.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, N. Y. Next meeting, Norfolk, Va.

INTERNATIONAL INDEPENDENT TELEPHONE ASSOCIATION. Secretary, A. L. Tetu, Nashville, Tenn.; assistant secretary, J. A. Harney, Electric Building, Cleveland, Ohio.

IOWA ELECTRICAL ASSOCIATION. Secretary, L. B. Spinney, Iowa State College, Ames, Iowa.

IOWA STREET AND INTERURBAN ASSOCIATION. Secretary, L. D. Mathes, Dubuque, Iowa.

IOWA TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Boone, Iowa.

KANSAS GAS, WATER AND ELECTRIC LIGHT ASSOCIATION. Secretary, James D. Nicholson, Newton, Kan. Next meeting, Topeka, Kan., October 16, 1907.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, J. W. Chambers, Winchester, Ky.

MAINE STREET RAILWAY ASSOCIATION. Secretary, E. A. Newman, 471 Congress street, Portland, Me.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby street, Boston, Mass. Meets second Wednesday of each month, except July and August.

MASTER CAR BUILDERS' ASSOCIATION. Secretary, J. W. Taylor, 390 Old Colony Building, Chicago, Ill.

MICHIGAN ELECTRIC ASSOCIATION. Secretary, A. C. Marshall, Port Huron, Mich.

MISSOURI INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James F. Barnett.

NATIONAL ARM, PIN AND BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Ind.

NATIONAL ELECTRICAL TRADES ASSOCIATION. Secretary, Fred P. Vose, 1343 Marquette Building, Chicago.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 94 Genesee street, Utica, N. Y. Next meeting, New York city, 1907.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, W. C. L. Eglin, 136 Liberty street, New York city.

NEW ENGLAND ELECTRICAL TRADES ASSOCIATION. Secretary, Alton F. Tupper, 84 State street, Boston, Mass.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, 114 Liberty street, New York.

NEW YORK STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, R. Max Eaton, Niagara Falls, N. Y.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, B. C. Adams, Madison, Wis.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO INDEPENDENT TELEPHONE ASSOCIATION. Secretary, Ralph Reamer, Portsmouth, Ohio.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS. Secretary, F. W. Bullard, Cleveland, Ohio.

OHIO STREET RAILWAY ASSOCIATION. Secretary, Charles Currie, Akron, Ohio.

OLD TIME TELEGRAPHERS AND HISTORICAL ASSOCIATION. Secretary, John Brant, 195 Broadway, New York city.

ORDER OF THE REJUVENATED SONS OF JOVE. C. B. Roulet, Mercury, Dallas, Tex.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Secretary, Samuel G. Reed, Portland, Ore.

PENNSYLVANIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, H. E. Bradley, 135 South Second street, Philadelphia, Pa.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION. Secretary, Charles H. Smith, Lebanon, Pa.

PIKE'S PEAK POLYTECHNIC SOCIETY. Secretary, E. A. Sawyer, Colorado Springs, Col. Meetings, second Saturday of each month.

RAILWAY SIGNAL ASSOCIATION. Secretary, C. C. Rosenberg, Bethlehem, Pa. Annual meeting, Milwaukee, Wis., October 14, 1907.

SOUTHWESTERN GAS, ELECTRIC AND STREET RAILWAY ASSOCIATION. Secretary, T. H. Stuart, Waco, Tex.

UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION. Secretary Electrical Committee, C. M. Goddard, 55 Kilby street, Boston, Mass.

VERMONT AND NEW HAMPSHIRE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, G. W. Buzzell, St. Johnsbury, Vt.

VERMONT ELECTRICAL ASSOCIATION. Secretary, C. C. Wells, Middlebury Electrical Light Company, Middlebury, Vt.

VIRGINIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, B. L. Fisher, Rocky Mount, Va.

WESTERN ASSOCIATION OF ELECTRICAL INSPECTORS. Secretary, W. S. Boyd, Chicago.

WESTERN SOCIETY OF ENGINEERS (Electrical Section). Secretary, J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

DATES AHEAD.

Electrical Trades Exposition. Chicago, Ill., January 14-26, 1907.

Northwestern Electrical Association. Chicago, Ill., January 16-18, 1907.

Jamestown Ter-Centennial Exposition. Norfolk, Va., April 26 to November 30, 1907.

Record of Electrical Patents.

Week of November 27.

836,666. ELECTRIC CONTROLLER. Roy W. Brown, Amsterdam, N. Y. Filed January 23, 1906. A number of switches are closed successively by a single mechanism.

836,691. STOP DEVICE FOR CIRCULAR KNITTING MACHINES. Ernest H. Ludwig, Manitowoc, Wis. Filed January 29, 1906. An electrically controlled stop device.

836,754. PROCESS OF IMPROVING THE MAGNETIC QUALITIES OF IRON-SILICON ALLOYS. Robert A. Hadfield, Sheffield, England. Filed February 27, 1906. The alloy is heated above its critical point and then cooled.

836,755. PROCESS OF IMPROVING CERTAIN MAGNETIC QUALITIES OF A MAGNETIC BODY. Robert A. Hadfield, Sheffield, England. Filed July 5, 1906. The alloy is maintained at a temperature between 700 and 800 degrees centigrade and then slowly cooled.

836,756. MAGNETIC ALLOY. Robert A. Hadfield, Sheffield, England. Filed July 5, 1906. An alloy of iron, silicon and manganese.

836,757. PROCESS OF IMPROVING THE MAGNETIC QUALITIES OF IRON-SILICON-MANGANESE ALLOYS. Robert A. Hadfield, Sheffield, England. Filed July 5, 1906. Manganese is added to an alloy of iron and silicon.

836,758. MAGNETIC ALLOY. Robert A. Hadfield, Sheffield, England. Filed July 5, 1906. An alloy of iron, silicon and aluminum.

836,759. METHOD OF MAKING MAGNETIC MATERIALS. Robert A. Hadfield, Sheffield, England. Filed July 5, 1906. An alloy containing silicon is reduced to sheet form and then successively heated and cooled.

836,760. METHOD OF MAKING MAGNETIC MATERIALS. Robert A. Hadfield, Sheffield, England. Filed July 5, 1906. An alloy containing silicon in the form of sheets is successively heated and cooled.

836,761. METHOD OF MAKING MAGNETIC MATERIALS. Robert A. Hadfield, Sheffield, England. Filed July 5, 1906. The alloy is heated to a temperature below its melting point and then rolled into sheets and again heated to a lower point.

836,762. PROCESS OF IMPROVING THE MAGNETIC QUALITIES OF IRON-SILICON-ALUMINUM ALLOYS. Robert A. Hadfield, Sheffield, England. Filed August 21, 1906. A magnetic alloy containing silicon and aluminum is successively heated and cooled.

836,774. ARC LAMP. Frederick S. Murray, New York, N. Y., assignor to the New York Calcium Light Company, New York, N. Y. Filed April 13, 1904. An arc lamp with a frustrum-shaped reflector.

836,789. PORTABLE ELECTRIC HOIST. Walter N. Vance, Chicago, Ill., assignor to the Yale & Towne Manufacturing Company, Stamford, Ct. Filed July 9, 1906. The motor and its controller are mounted on a hoisting sheath.

836,794. AUTOMATIC DEVICE FOR OPERATING VALVES AND OTHER MECHANISMS. Oscar Winter and Fred W. Waterman, Elyria, Ohio. Filed February 17, 1906. A gravity actuated, electrically released valve.

836,805. TELEPHONE OR SWITCHBOARD PLUG. Alva B. Dozier, Taylor, Tex. Filed May 10, 1904. A method of construction.

836,808. ELECTRIC TIME SWITCH. John Gunning, Bournemouth, England. Filed December 16, 1905. A spring-actuated time-switch.

836,836. TRANSMISSION TOWER. Daniel R. Scholes, Chicago, Ill., assignor to Aermotor Company, Chicago, Ill. Filed February 21, 1906. A tower of structural iron with a truss-formed cross-arm.

836,848. TELEPHONE APPARATUS. David H. Wilson, Chicago, Ill., assignor to George W. Kretzinger, Chicago, Ill. Filed December 8, 1902. The telephone receiver is mounted opposite the pole pieces of an induction coil.

836,863. PROCESS OF MAKING ELECTRIC CONDENSERS. Henry P. Clausen, Chicago, Ill., assignor to American Electric Telephone Company, Chicago, Ill. Filed February 2, 1903. A metal sheet is laid between paper dipped in paraffin and two such elements folded into a convenient form.

836,895. ELECTRIC BLOCK SIGNAL. Walter E. Sands, Brooklyn, N. Y., assignor to the L. A. Thompson Scenic Railway Company, New York, N. Y. Filed December 29, 1905. The signals are actuated by the cars.

836,904. AUTOMATIC SYSTEM OF INTERCOMMUNICATION. Anthony Van Wagenen, Sioux City, Iowa. Filed July 31, 1902. Renewed March 3, 1906. The switches at the exchange are operated by magnets branched across the subscriber's lines.

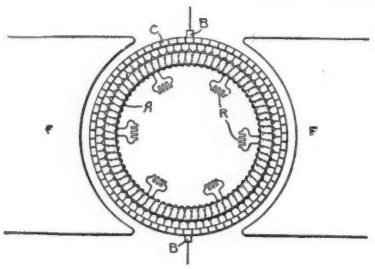
836,915. ILLUMINATED SIGN. William T. Bradshaw, Oakland, and Charles H. Townsend and Oscar F. Erickson, Berkeley, Cal. Filed August 7, 1906. Curved reflectors are provided to throw the light from a few lamps through a number of openings.

836,936. TEMPORARY TELEGRAPH STATION. Chas. S. Maynard, Chardon, Ohio, assignor of one-fourth to John Maynard and one-fourth to W. B. Treat, Cleveland, Ohio. Filed September 24, 1906. A clip for cutting in on a telegraph line.

836,965. ELECTRIC DOOR-OPENER. Edwin W. Fyler, Hyde Park, Mass., assignor of one-half to Warren E. Fyler, Hyde Park, Mass. Filed April 9, 1906. An electromagnetic door-striker.

836,973. SYSTEM OF MOTOR CONTROL. George H. Hill, Schenectady, N. Y., assignor to General Electric Company. Filed May 20, 1905. A controller system of the unit-switch type, actuated pneumatically, controlled electrically.

836,974. METER. Frank Holden, Rugby, England, assignor to General Electric Company. Filed April 24, 1905. The rotating member is immersed in a conducting bath placed in a magnetic field.



836,978.—ALTERNATING CURRENT MOTOR.

836,978. ALTERNATING-CURRENT MOTOR. Marius C. A. Latour, Paris, France, assignor to General Electric Company. Filed May 16, 1905. The armature has a plurality of separate windings connected to successive commutator segments, and connections are made between a plurality of equipotential points.

836,981. TRAIN-CONTROL SYSTEM. Charles E. Lord, Cincinnati, Ohio, assignor to General Electric Company. Filed October 1, 1904. A pneumatically operated motor-controlled system.

836,982. EMERGENCY BRAKE. George Macloskie, Schenectady, N. Y., assignor to General Electric Company. Filed March 21, 1903. Renewed March 7, 1906. An attachment on the controller applies the brake if the controller handle be released.

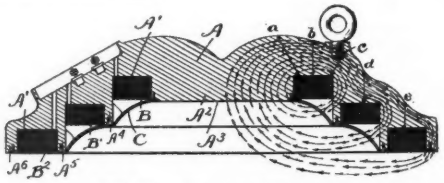
836,998. ALTERNATING-CURRENT MOTOR. Ernest Schweiger, Schenectady, N. Y., assignor to General Electric Company. Filed May 2, 1904. The motor is provided with a secondary winding connected to a commutator with short-circuiting brushes.

837,022. SAFETY APPARATUS FOR RAILWAYS. Granville T. Woods and Lyates Woods, New York, N. Y., assignors to General Electric Company, Schenectady, N. Y. Filed October 5, 1904. The brake apparatus may be brought into action by a movement of the motor controller.

837,023. CIRCUIT-BREAKER. Gilbert Wright, Pittsfield, Mass., assignor to Stanley Electric Manufacturing Company, Pittsfield, Mass. Filed January 11, 1904. The circuit-breaker is opened by a series coil and held open by a shunt coil.

837,033. COOLING DYNAMO-ELECTRIC MACHINES. Paul Bunet, Paris, France, assignor to General Electric Company. Filed March 23, 1905. The commutator bars are provided with heat-radiating wings.

837,037. MOTOR-CONTROL APPARATUS. Frank E. Case, Schenectady, N. Y., assignor to General Electric Company. Filed April 17, 1905. A unit switch-control system, certain of the units being controlled automatically.



837,174.—LIFTING MAGNET.

837,044. TESTING DEVICE. Alvarado L. R. Ellis, Lynn, Mass., assignor to General Electric Company. Filed October 23, 1905. The effective strength of a magnet is tested by comparison with a standard.

837,054. CONSTRUCTION OF INCANDESCENT ELECTRIC-LAMP SOCKETS. Gilbert W. Goodridge, Bridgeport, Ct., assignor to the Bryant Electric Company, Bridgeport, Ct. Filed April 9, 1906. The cap is provided with spring clips for holding to the case.

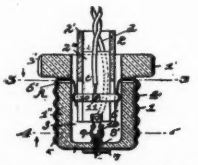
837,055. CONSTRUCTION OF INCANDESCENT-ELECTRIC-LAMP SOCKETS. Gilbert W. Goodridge, Bridgeport, Ct., assignor to the Bryant Electric Company, Bridgeport, Ct. Filed April 9, 1906. The cap is held to the case by clips and is notched to prevent rotation.

837,066. METER. Frank Holden, Rugby, England, assignor to General Electric Company. Filed November 17, 1905. The rotating member consists of a plurality of conductors submerged in a conducting liquid which connects them in series.

837,073. INCANDESCENT-LAMP SOCKET. William W. Jones, Bridgeport, Ct., assignor to the Bryant Electric Company, Bridgeport, Ct. Filed May 12, 1906. A two-member lamp socket, the parts of which are held together by spring catches.

837,084. APPARATUS FOR ILLUMINATING PHOTOGRAPHIC STUDIOS WITH ELECTRIC INCANDESCENT LAMPS. Philipp G. von der Lippe, Vienna, Austria-Hungary. Filed January 9, 1906. A device providing movable lamp sockets.

837,092. CIRCUIT-BREAKER. William Merrill, Wilmington, Del. Filed October 19, 1905. The switch is held open or closed by a tube containing liquid.



837,184.—ATTACHMENT PLUG.

837,097. ELECTRIC ALARM. Ernest S. Moorer, Anderson, S. C. Filed September 16, 1905. A thermal alarm for attaching to telephone or other circuits.

837,154. RAILWAY SIGNALING SYSTEM. Louis H. Thullen, Edgewood Park, Pa. Filed May 22, 1905. The signals are controlled by pulsating currents sent out over the motor circuit.

837,174. LIFTING MAGNET. Charles E. F. Ahlm, Cleveland, Ohio, assignor to Cleveland Armature Works, Cleveland, Ohio. Filed May 22, 1906. Two or more concentric pole-pieces are provided.

837,178. AUTOMATIC CIRCUIT-CLOSER. Tully W. Benson, Wewoka, Ind. Terr. Filed January 4, 1906. An automatic telegraph circuit-closer.

837,182. ATTACHMENT PLUG FOR ELECTRIC LIGHTING. David E. Bown, Pittsburg, Pa. Filed August 14, 1905. A method of construction.

837,183. FUSE PLUG FOR ELECTRIC LIGHTING. David E. Bown, Pittsburg, Pa. Filed August 14, 1905. The fuse is contained within a chamber of the plug.

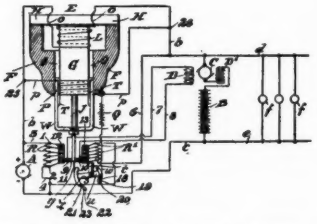
837,184. ATTACHMENT PLUG. David E. Bown, Pittsburg, Pa. Filed November 6, 1905. A swivelling plug.

837,185. AERIAL-CABLE SUPPORT. Charles L. Brown, Philadelphia, Pa. Filed July 21, 1905. A wire-loop support.

837,201. AUTOMATIC CIRCUIT-BREAKER. Albert E. Doman, Elbridge, N. Y., assignor to the Elbridge Electrical Manufacturing Company, Elbridge, N. Y. Filed May 21, 1902. The brake is opened by an intermittently acting make-and-break device.

837,213. ELECTRIC MOTOR. Manes E. Fuld, Baltimore, Md. Filed February 6, 1906. A toy motor.

837,227. RAILWAY-SIGNALING SYSTEM. Joseph G. Horazdovsky, Cleveland, Ohio, assignor of one-sixth to John J. Koller, one-sixth to Ladimir Herold, and one-third to Victor Nusbaum, Cleveland, Ohio. Filed May 21, 1906. A train-operated system.



837,231.—SYSTEM OF ELECTRIC REGULATION.

837,231. SYSTEM OF ELECTRIC REGULATION. Joseph Bijur, New York, N. Y., assignor to the General Storage Battery Company, New York, N. Y. Original applications filed September 24, 1904. Divided and this application filed February 17, 1905. A method of controlling a battery-charging booster.

837,241. ELECTRIC SWITCH. William J. Murray, Leavenworth, Kans., assignor of one-half to Herbert W. Wolcott, Leavenworth, Kans. Filed May 2, 1905. A rotating snap-switch.

837,256. TELEPHONE TOLL APPARATUS. Edward P. Baird, Evanston, Ill., assignor to Baird Manufacturing Company, Chicago, Ill. Filed May 11, 1903. A plurality of coin-shifters is provided and means for closing the coin slots.